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THE A. M. A. METHOD OF APPRAISAL OF VISUAL EFFICIENCY*

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INTRODUCTION

In 1919 the Section on Ophthalmology of the American Medical Association appointed a committee on compensation for eye injuries. The aim of this committee was to establish a method of determining the loss of visual efficiency of a person who has suffered any degree of impairment of vision as the result of occupational disease or injury. Such loss was to be the basis for determination of the amount of compensation. After several preliminary reports and incidental investigations the committee made a report which was adopted May 26, 1925, by the House of Delegates of the American Medical Association and recommended to all compensation agencies as a basis for the appraisal of loss of visual efficiency. In 1927, the committee reported that many agencies were employing the method generally. During subsequent years the committee designed a set of test cards and recording charts for use as a special kit in appraisal examinations.

In 1940, a general revision was made by the same committee and adopted by the House of Delegates of the American Medical Association to supersede the 1925 report. The revisions consisted mainly in correcting minor errors, clarifying certain steps in the testing and appraisal procedure, and changing a recommendation that was originally intended for the guidance of legislative bodies and policy forming agencies concerned with compensation. Originally it was assumed that existing compensation rulings would have to be changed to conform to the

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American Medical Association procedure. It was subsequently discovered that most of the already existing statutes and regulations were adaptable by interpretation in that they typically specified the compensation for the special conditions of either the loss of one or both eyes and hence intermediate values of visual efficiency could be computed from the American Medical Association formula by interpolation or extrapolation. In instances in which provisions had been made only in terms of "total disability of the individual" the formula is still applicable because the assumption is made that the total loss of vision is identical with the total disability of the individual. Inasmuch as the recommended formula rates the complete loss of one eye to be equivalent to one-fourth the loss of both eyes, the stipulated compensation for the loss of one eye would have to be equal to one-fourth the stipulated compensation for total disability in order for the formula to apply unambiguously. It is not clear what compromises are to be made if a given agency pre-stipulates both the compensation for the loss of one eye and the compensation for total disability in a ratio not conforming to the ratio inherent in the formula.

THE GENERAL FORMULA

The American Medical Association method of appraisal of visual efficiency is based upon the assumption that there are three "primary and coordinate factors of vision," namely, "acuteness of vision" (central visual acuity), "field of vision," and "muscle function." The efficiency of a given eye is then expressed as a product of these three factors. Of the three factors, the first two are represented in each of the two eyes, while the third is treated as a binocular function. As a binocular function it is considered a factor in the less efficient eye only.

The assumption that it is a binocular function makes it necessary to determine, first, which of the two eyes is less efficient. Presumably this is done by obtaining the product of the first two factors, CP and C′P′ in formulas (1) and (2), and comparing. The value of the muscle function, M, is then combined as a factor in the computation of the efficiency of the less efficient eye only. The efficiency value for each of the two eyes may then be expressed as follows:

$$E = CP \qquad (1)$$

and

$$E' = C'P'M \qquad (2)$$

where E = efficiency rating of the more efficient eye
E' = efficiency rating of the less efficient eye
C = acuteness-of-vision factor of the more efficient eye

C′ = acuteness-of-vision factor of the less efficient eye
P = field-of-vision factor of the more efficient eye
P′ = field-of-vision factor of the less efficient eye
M = the muscle function

It is next assumed that the more efficient eye contributes three times as much toward the total visual efficiency as the less efficient eye. If V. E. is used to express the total or resultant visual efficiency of the individual, the formula for V. E. becomes

$$\text{V. E.} = \frac{3E + E'}{4} = \frac{3CP + C'P'M}{4} \qquad (3)$$

THE CENTRAL ACUITY FACTOR

The evaluation of C and C′ is based upon the Snellen acuity test in accordance with the following formula:

$$C = .836^{(\frac{1}{S}-1)} \qquad \text{and } C' = .836^{(\frac{1}{S'}-1)} \qquad (4)$$

in which S and S′ = Snellen fractions of the more efficient eye and less efficient eye respectively.

This formula was invented by Sterling and Snell[8] to fit an experimentally obtained curve showing the relationship between the Snellen acuity and the number of etched glass plates directly in front of the eyes of a normal subject. It was assumed that each addition of an etched glass plate represented an equal reduction in efficiency. The results were also compared to statistical studies of the efficiency of industrial workers with eye injuries and reported to be in agreement.

It is recommended that where the Snellen fractions for distance and near differ the efficiency ratings should be averaged as follows:

$$C = \frac{C_d + C_n}{2}, \text{ and } C' = \frac{C'_d + C'_n}{2} \qquad (5)$$

in which C_d = the acuity efficiency rating of the more efficient eye, at 20 ft. or 6M.

C_n = the acuity efficiency rating of the more efficient eye, at 14 in. or 35 cm.

C'_d = the acuity efficiency rating of the less efficient eye, at 20 ft. or 6M.

C'_n = the acuity efficiency rating of the less efficient eye, at 14 in. or 35 cm.

Each of the above acuity-efficiency ratings may be represented, from equation (4), as follows:

$$\left.\begin{aligned} C_d &= .836^{\left(\frac{1}{S_d}-1\right)} & C_n &= .836^{\left(\frac{1}{S_n}-1\right)} \\ C'_d &= .836^{\left(\frac{1}{S'_d}-1\right)} & C'_n &= .836^{\left(\frac{1}{S'_n}-1\right)} \end{aligned}\right\} \qquad (6)$$

The values of C_d, C_n, C'_d, and C'_n may also be obtained directly from Table 1.

TABLE I

Acuity-Efficiency Rating Corresponding to Snellen Notations for Distant and for Near Vision

Snellen Notation for Distance (S_d or S'_d)	Snellen Notation for Near (S_n or S'_n)	Acuity-Efficiency Rating (C_d, C'_d, C_n, or C'_n)
20/20	14/14	1.000
20/25	14/17.5	.957
20/30	14/21	.915
20/35	14/24.5	.875
20/40	14/28	.836
20/45	14/31.5	.800
20/50	14/35	.765
20/60	14/42	.699
20/70	14/49	.640
20/80	14/56	.585
20/90	14/63	.534
20/100	14/70	.489
20/120	14/84	.409
20/140	14/98	.342
20/160	14/112	.286
20/180	14/126	.239
20/200	14/140	.200
20/220	14/154	.167
20/240	14/168	.140
20/260	14/182	.117
20/280	14/196	.097
20/300	14/210	.082
20/320	14/224	.068
20/340	14/238	.057
20/360	14/252	.048
20/380	14/266	.040
20/400	14/280	.033
20/450	14/315	.021
20/500	14/350	.014
20/600	14/420	.006
20/700	14/490	.003
20/800	14/560	.001

The A. M. A. has prepared distance and near acuity test charts for use at 20 feet and 14 inches with the various sizes of Snellen letters designed directly in terms of the acuity-efficiency rating, e.g., the regular 20/20 letters are marked 100% or 1.00, the 20/40 as 83.6% or .836, etc.

The recommended acuity testing procedure includes specifications to the effect that the subject shall wear the prescription giving the maximum obtainable acuity at distance and near in each eye, except that the correction for anisometropia shall not exceed 4.00 diopters, in which case the acuity of the poorer eye shall be measured through a lens which is not more than 4.00 diopters greater or less than the lens for the better eye. Presumably the anisometropia is to be taken into account separately at distance and near; whether or not bifocals or different prescriptions for distance and near may be worn during the acuity test is not clear, but it is implied that they may be worn. The illumination is to be not less than 10 foot candles nor more than 20 foot candles on the surface of the chart.

THE FIELD OF VISION FACTOR

The values for P and P′ are determined by the use of the usual perimetric test methods, a white target which subtends a one degree angle being employed under illumination of not less than 5 foot candles, and the results plotted on an ordinary visual field chart. The sum of the radial dimensions in the eight field sectors, measured in their principal meridians, is divided by 500 to give the field-efficiency rating P and P′. The normal value for each meridian is given in Table II.

TABLE II

Anatomical Direction	*Degree Designation*		*Normal Limit*
	O.D.	O.S.	
Temporal	180°	0°	85°
Superior Temporal	135°	45°	55°
Superior	90°	90°	45°
Superior Nasal	45°	135°	55°
Nasal	0°	180°	60°
Inferior Nasal	315°	225°	50°
Inferior	270°	270°	65°
Inferior Temporal	225°	315°	85°
			Total = 500

It is implied in the A. M. A. recommendation that the value employed for any one radial dimension shall not exceed the normal value given in the table, i. e., if the temporal measurement actually reveals a field extending 100° from the point of fixation the value should be recorded as 85° for the purpose of the formula.

A few examples selected from the American Medical Association instruction booklet[2] help to show the operation for determining the visual field factor P (or P′):

Example 1. The field of vision is contracted 20° in all eight meridians:

$$P = \frac{500 - (20 \times 8)}{500} = .68$$

Example 2. The entire temporal field is lost:

$$P = \frac{45 + 55 + 60 + 50 + 65}{500} = .55$$

Example 3. The upper inner quadrant is lost:

$$P = \frac{500 - 55}{500} = .89$$

It is seen from these examples that a hemianopsia is intended to represent less than one-half loss of the visual field function: likewise the loss of a quadrant is intended to represent less than one-fourth loss of the visual field function.

No specific instructions are given for the evaluation of P in case of a peripheral circumscribed scotoma, but it may be guessed that the radial dimension for the sector in which such a scotoma exists is to be represented by the distance from the point of fixation to the central border of the scotoma. In such a case the field of vision beyond the scotoma would be considered to contribute nothing.

THE MUSCLE FUNCTION FACTOR

The evaluation of M is based upon the absence of single binocular vision in all or in parts of the normal field of fixation as identified either by the presence of diplopia, by the objective observation of squint, or by the demonstration of inability to direct the fixation of one or the other eye to the various parts of the normal field of fixation. No specific instructions are made in regard to measuring or testing techniques: it is only recommended that "recognized methods" be used.

The area of the field affected by the loss of muscle function is plotted on the specially designed A. M. A. Industrial Motor Field Chart illustrated in Figure 1. The total area of the chart is intended to represent, for the purposes of efficiency appraisal, a normal motor or fixation field. The primary position of fixation is represented in the chart by a small square 10° above the center of the diagram. The chart itself is square, extending 40° superior to the primary point of fixation, 60°

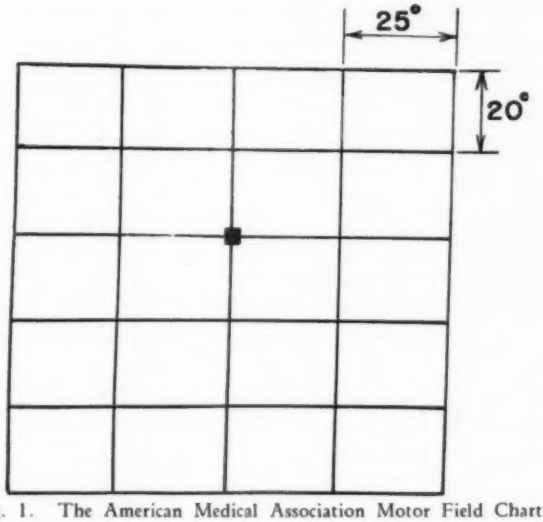

Fig. 1. The American Medical Association Motor Field Chart.[2]

inferior, and 50° laterally in each direction. The total area of the chart is subdivided into 20 rectangles each representing a 20° vertical and a 25° horizontal segment of the total field. The loss of muscle function is rated as 5 per cent, or one-twentieth, for each rectangle of the motor field in which there exists diplopia, squint, or loss of fixation. Thus, for example, if diplopia occurs in 9 of the 20 rectangles,

$$M = \frac{20 - 9}{20} = .55$$

The peculiar status of M in the general formula (3) is afforded by the recommendation[2] that ". . . the factor of loss of muscle efficiency should be used only in computing the efficiency of the less efficient of the two eyes." This recommendation is qualified to apply only "when an injury has involved both eyes." No examples are given to illustrate how compensation would be computed for extra-ocular muscle injuries received by a one-eyed person, but it is evident that under the general formula no loss of efficiency would be acknowledged.

Section V of the manual[2] is devoted to "Industrial Visual Efficiency of One Eye." It is not clear whether this pertains to the compensation for injuries received by a previously one-eyed person, the compensation for injuries received when only one eye remains intact, or whether it merely illustrates the computation of the efficiency of the less efficient of the two eyes. It is conceivable that the committee intended a special

method of evaluation for one-eyed cases. The possible intentions are not considered in the present discussion. In any event, some consideration for muscle injuries not provided for in the general formula would be included as an incidental consideration.

INCIDENTAL CONSIDERATIONS

Certain types of ocular disturbance are admittedly not included in the foregoing computations because of the lack of criteria and tests for providing quantitative specification. "Such are disturbances of accommodation, of color vision, of adaptation to light and dark, metamorphopsia, entropion, ectropion, lagophthalmos, epiphora, and muscle disturbances not included under diplopia." It is recommended that for such disabilities additional compensation should be awarded, but that in no case shall such additional award make the total compensation for loss in industrial efficiency greater than that provided by law for total loss of one eye when only one eye is involved, and that for total permanent disability when both eyes are involved.

Compensation for loss in industrial visual efficiency, as provided for above, does not include compensation for any cosmetic defect, for mental or physical suffering, for cost of medical attention, or for the time lost from gainful occupation during the period of treatment previous to final computation of compensation. It is recommended that such compensation should be awarded on a separate basis.

It is recommended that compensation shall not be completed until "all adequate and reasonable operations and treatment known to medical science" have been attempted to correct the defect. Final examination on which compensation is to be based shall not be made until at least three months shall have elapsed after all visible evidence of inflammation have disappeared, except in cases of disturbance of extrinsic ocular muscles, optic nerve atrophy, sympathetic ophthalmia and traumatic cataract; in such cases at least 12 months and preferably not more than 16 months shall intervene before the examination shall be made on which final compensation is to be computed.

In cases of additional loss in visual efficiency when it is known that there was present pre-existing subnormal vision, compensation shall be based on the loss incurred as a result of the eye injury or occupational condition specifically responsible for the additional loss. That is, the compensation will be based upon the difference between the V. E. computed on the basis of conditions existing prior to injury and the V. E. computed subsequent to injury. In cases in which there exists no record or no adequate and positive evidence of pre-existing subnormal vision,

it shall be assumed that the visual efficiency prior to any injury was 100 per cent.

SUMMARY OF FORMULAE

By combining formulas (3) and (5) the general formula for visual efficiency may be stated as follows:

$$\text{V. E.} = 3P\frac{C_d + C_n}{8} + MP'\frac{C'_d + C'_n}{8} \qquad (7)$$

in which

P and P′ = the sum of the radial dimensions of the eight principal meridians of the visual field of the more efficient eye and the less efficient eye respectively.

M = the ratio of the area of the motor field intact to the area of the normal motor field prescribed by the A. M. A.

C_d and C'_d = A. M. A. acuity-efficiency ratings for the distance vision of the more efficient eye and less efficient eye respectively.

C_n and C'_n = A. M. A. acuity-efficiency ratings for the near (14″) vision of the more efficient eye and less efficient eye respectively.

C_d, C'_d, C_n, and C'_n may be computed from the Snellen fraction in accordance with formula (6), the general form of which is

$$C = 0.836^{\left(\frac{1}{S} - 1\right)}$$

in which S = the Snellen fraction for the given testing situation.

AUTHOR'S ABSTRACT

The method of appraisal of visual efficiency adopted by the American Medical Association is reviewed and in part restated. The essential features of the method are incorporated in a general formula which lends itself to simple mathematical treatment. The attempt to restate the method of appraisal in mathematical terms brings out certain difficulties of interpretation of the intent of the committee formul ting the method.

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THE CORNEAL LENS*

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While there has been no dearth of contact lens reports in the literature, it is the writer's hope that this article, by the clarification of corneal lens concepts and misconceptions, and by the presentation of a simplified fitting procedure, may stimulate refractionists to utilize a valuable addition to their means of alleviating the human suffering caused by visual difficulties.

The corneal contact lens has been available for use in private practice for the past year, after two years of private development and research at the College of Medical Evangelists, Los Angeles. The lens is not merely a fluidless contact lens, but embodies well known physical, physiological and optical principles which will be presented in this article.

Contact lenses afford, theoretically, the ideal correction for ametropia. The contact lens rotates with the eye, thus negating the difficulties arising from fixation away from the optical center of the spectacle lens. In anisometropia, contact lenses overcome prismatic imbalance. In the ordinary high ametropias (myopia, hyperopia, regular astigmatism) the visual acuity obtained often surpasses that of the spectacle lens. Irregular astigmatism caused by keratoconus, corneal scars, corneal dystrophies, etc., cannot be adequately corrected by ordinary lenses, but a spectacular degree of good vision is obtained with contacts. In lid pathologies such lenses serve as prophylactic devices for the cornea. In binocular aphakia, the disturbing aberrations induced by fixation through the periphery of the strong convex lenses is not present with contact lenses. In monocular aphakia, with correction by ordinary means, binocular vision is practically impossible due to image size differences and prismatic imbalance. When corrected by contact lenses, useful, comfortable binocular vision is frequently attained. The cosmetic value of contact lenses is obvious.

Unfortunately, the usual type contact lens had a major impediment to its constant utility, namely, the clouding of vision due to changes in the corneal epithelium after wearing for a few hours.

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The corneal lens represents a significant milestone in refractive achievement. It eliminates the fogging of the cornea, requires no accessory fluid, requires no specialized equipment other than that necessary for adequate eye care, permits easy insertion and removal by practitioner and patient, does not change the natural appearance of the eye, and has the added advantage of negligible pressure because of its thinness and lightness of weight.

The basic theory underlying the corneal lens is a departure from that governing the conventional contact lens. While the principles preliminary to the fitting procedure may appear elementary, the writer must admit that it was necessary on his part to review basic material in order to appreciate the purposes of corneal lens technique. The possibility is that others would be helped by a brief discussion of such pertinent concepts.

In order to clarify the principles involved, this discussion is divided into the following phases:

1. Physical
2. Physiological
3. Optical
4. Fitting procedure
5. Discussion
6. Miscellaneous notes
7. Conclusion

PHYSICAL CONCEPTS

A. The Lens:

The corneal lens is a small thin meniscus of plastic (methylmethacrylate) which rides upon the tears bathing the cornea. Its weight is about ½ gram. Both surfaces are highly polished. The concave surface is determined by the radius of curvature of the cornea. The convex front curve is determined by the prescription for the ametropia. The lens is bevelled at the periphery of the ocular surface in a zone approximately 1 mm. wide. The bevelled area presents a flatter surface for contact with the limbus. The thinned edge is perfectly smooth and rounded. The lens has a diameter of 11.5 mm. in its regular size. See Figures 1, 2 and 3.

B. Basic Physical Principles:

The lens has a radius of curvature which is approximately 3/10 mm. longer than the longest radius of curvature of the cornea. This permits the presence of the lubricating film of tears between lens and cornea. The lens does not fall out of the eye because of the adhesiveness induced by lowered surface tension. The lens floats on the pre-

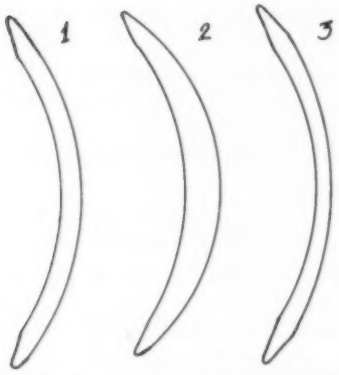

Fig. 1. Cross section corneal lens with plano power.
Fig. 2. Cross section corneal lens with +10.00 sph. power.
Fig. 3. Cross section corneal lens with —10.00 sph. power.

corneal film but does not depart significantly from the limits of the limbus because its curvature is more compatible with that of the cornea than with that of the sclera.

PHYSIOLOGICAL CONCEPTS

A. Basic anatomy and physiology:

When the eye is in the primary position, the upper lid just covers the upper part of the cornea while the lower lid is just free of the lower border of the cornea. The cornea is not truly spherical. In the central or optical zone, which is about 4 mm. in diameter, the cornea is normally almost spherical. Toward the periphery it becomes somewhat flattened, especially on the nasal side. The radius of curvature of the optical zone of the anterior surface of the cornea is usually between 7.5 mm. and 8.0 mm.

The posterior border of the lid margin is sharp and placed against the globe. Involuntary blinking occurs at the rate of 2 to 30 times per minute.

B. The Lens in Relation to Eye Physiology:

The corneal lens rides freely on the surface of the cornea. The relationship of the lens to the cornea is such that the lens is sufficiently loose to provide a free flow of lacrimal fluid between the posterior surface of the lens and the anterior surface of the cornea. Thus actual corneal contact does not occur. By examination with a corneal microscope, the lens is seen to rest everywhere upon a lubricating film of tears which is swirling continuously beneath the lens.

Because of the looseness required, the position of the lens at any

given time in the majority of cases is determined by *gravity* and *lid action.*

With the eye in the preliminary position and with the lids retracted, the lens, due to gravity, tends to fall below the inferior border of the cornea. When the lids assume their normal position, this gravity drop is overcome by lid action, i. e., blinking. In the act of blinking, as the upper lid descends, it cups the lens and retrieves it. As the upper lid elevates itself, the lens is raised to the proper position on the cornea.

When the eye looks straight ahead, the upper portion of the lens is normally covered by the upper lid, while its lower edge is situated slightly above the lower lid margin.

When the eye rotates upward, the upper lid is elevated and the lens tends to drop momentarily because of gravity, but it is retrieved by the upper lid in blinking so that it returns to its optimum position again.

When the eye rotates laterally, the lens lags slightly in the direction opposite to the rotation, e.g., if the eye rotates temporally, the lens lags slightly nasally, as indicated by the margin of the lens extending slightly beyond the periphery of the cornea. This occurs because the rotation of the eye describes an arc, while the lids grasp the lens and hold it back slightly. The lens, then, becomes situated somewhat tangent to the arc of rotation of the eye, in extreme positions of lateral gaze. The bevel on the inside surface of the lens permits the lens to ride up on the sclera underneath the upper lid for approximately 1 mm. without scleral impringement or pressure. This is desirable for good positioning. The lens will not proceed any higher as the scleral curvature is too flat in relation to the curvature of the bevel.

Basically, the adjustment which the eye makes to the corneal lens is twofold:

1. adaptation of the lids
2. adaptation of the cornea

It will be remembered that the inner portion of the lid margin is sharp and in close contact with the globe. Since the diameter of the lens is smaller than the diameter of the cornea, the lid margins travel across the edges of the lens and feel them despite the thinness and smoothness of the edges. The initial sensations resulting from this condition may be quite prominent, precisely as the lids react when they feel any foreign body on the eyeball. These lid sensations rapidly diminish. Various theories have been advanced for this phenomenon. The most accepted theory is that the lid muscles relax the tension initially exerted on feeling a foreign body in the eye. In the majority

of cases, the lids learn to accept the lens, and the wearing time rapidly increases from that point on. A sensation of itching and smarting is localized in the upper lid, and is transient during the adaptation period. Removal of the lens immediately abolishes the symptom. The lens can then be reinserted for further wear.

The cornea, according to certain authorities, adapts itself to the lens by means of a "toughening" process which is not well understood. This "epithelial toughening" is not demonstrable clinically, nor does it hinder the sensitivity of the cornea to any other foreign body. The rapidity with which the cornea "toughens" varies with different individuals.

The writer does not wholly agree with this theory. It is the writer's opinion that there exists some interference with the metabolism of the cornea as a result of the application of the lens. However, the cornea apparently slowly adjusts itself to a new rate of metabolism, much as the organism adjusts itself on removal from a low altitude to a high altitude area with rarefied air.

To achieve normal metabolism, the cornea requires good circulation of the blood at the limbus, and a sufficient bathing and circulation of the tears in conjunction with adequate movement of the eyelids. For optimum performance, a contact lens must be so related to the cornea that the fluid between lens and cornea can circulate freely and replace itself continuously. The corneal lens is based on this principle in that the fluid between the lens and the cornea is the patient's own lacrimal fluid which circulates continuously and replenishes itself in the same manner as if the lens were not present. The corneal lens does not significantly interfere with corneal metabolism.

True corneal fogging, per se, does not occur *when the corneal lens is properly fitted and the patient obeys the doctor's instructions.* This lack of corneal misting permits eventual unlimited wearing time. With the introduction of any foreign body into the conjunctival sac, there occurs, besides excess lacrimation, increased secretion of mucus and sebaceous material. In the first periods of use, as the lacrimation subsides, these secretions may condense and appear on the outside surface of the lens, inside surface of the lens, suspended between lens and cornea, or on the anterior surface of the cornea. This deposition causes a slight fogging of vision. The fog moves with the blinking of the lids. If the lens is removed, cleansed and replaced on the cornea, the fog is no longer present.

OPTICAL CONCEPTS

Mathematical computations of theoretical interest are beyond the

scope of this article as the writer is primarily interested in presenting the optical considerations from the practical point of view as it has a bearing in everyday routine practice.

Primarily we are here concerned with the following:

1. Curvature of the anterior surface of the cornea
2. The lacrimal lens formed between cornea and corneal lens
3. The corneal lens
4. Centering

The optical effect of the slight layer of tears and secretions present on the anterior surface of the contact lens may be considered negligible as this thin film is always present on the cornea, and varies with evaporation, blinking rate, etc.

In the normal eye, *the anterior surface of the cornea* contributes about 43.00 D. to the total refractive power of the eye. Paradoxically, this surface becomes non-existent optically when corneal lenses are worn. This occurs because the corneal lens is separated from contact with the cornea by a thin layer of tears. This layer of tears is termed the *"lacrimal lens."* Since the indices of refraction of the lacrimal lens and of the cornea are practically the same, and since the lacrimal lens is in contact with the cornea, the anterior surface of the cornea is eliminated as a refractive surface. Figure 4.

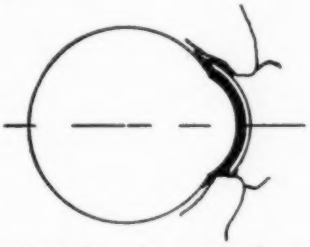

Fig. 4. Tuohy Corneal Lens. The Lacrimal lens.

The Lacrimal Lens:

The anterior surface of the cornea forms the posterior surface of the lacrimal lens. The posterior surface of the lacrimal lens is therefore identical in curvature with the anterior surface of the cornea, but *opposite* in power, i.e., a concave curve. The posterior surface of the corneal lens forms the anterior surface of the lacrimal lens. It is therefore identical in curvature with the posterior surface of the corneal lens, but *opposite* in power, i.e., a convex curve.

Assuming a spherical cornea for illustration, the corneal lens is chosen with a radius of curvature of its posterior surface approximately

3/10 mm. longer than the radius of curvature of the cornea. Therefore, we have a lacrimal lens whose radius of curvature of its anterior surface is 3/10 mm. longer than that of its posterior surface, thus forming a concave meniscus. The lacrimal lens has a power of about —1.50 D. due to the difference in the index of the plastic (n=1.49) and the tears (n=1.337).

With an astigmatic cornea, a corneal lens is chosen whose radius of curvature is 3/10 mm. longer than the meridian of the longest radius of curvature (weakest power) of the cornea. Thus, the concavity of the lacrimal lens is maintained with corneal astigmatism. This also maintains the optimum relationship of a lacrimal lens no thinner than approximately 3/10 mm. at the apex of the cornea.

The Corneal Lens:

The cylinder on the astigmatic anterior surface of the cornea is obviously a plus cylinder since this surface is a convex surface. The posterior surface of the lacrimal lens is necessarily a minus cylinder since it is in contact with and is formed by the anterior surface of the cornea. Therefore, the spectacle correction is transposed to minus cylinder form and then only the spherical portion of the spectacle correction need be transposed to the plane of the cornea, for the lacrimal lens negates the astigmatism of the anterior surface of the cornea. The correction in the plane of the spectacle lens is calculated at the plane of the cornea taking into account the vertex distance. The power of the corneal lens when added to the minus power of the lacrimal lens will equal the effective correction of the patient in the plane of the cornea.

Centering:

In the *low or medium ametropias*, with the eye in the primary position, the lens assumes a position such that its center is slightly high in relation to the anterior pole of the cornea. However, this position is not constant as the lens moves freely over the corneal surface, but not in excess of approximately 1 mm. in any direction.

In directions of lateral gaze, the lens lags slightly, as explained in the section on "Physiological Concepts." This is compensated by the blinking of the upper lid which returns the lens to its proper position on the cornea. On rotation upward, the lens tends to drop, but is retrieved by the upper lid so that it is returned to its proper positioning. On rotation downward, because of the marginal bevel, the lens cannot rise above the superior limbus to a significant extent, therefore the lens with the cornea passes beneath the lower lid. In oblique movements of the eye, the above principles are utilized with the end result that the lids center the lens properly in any position.

In the *high ametropias* where good centering is definitely indicated, it is attained in a similar manner. With the eye in the primary position, the lens is situated slightly below the anterior pole of the cornea because of its weight. The blinking process again results in true centering. In the blink, as the upper lid descends, it forces the lens down further; as the upper lid rises, the lens is elevated to a position slightly above center. From this point the lens falls to its true centered position.

In directions of lateral gaze, the lens will lag excessively. This ordinarily should cause appreciable induced prism. Here again the blinking of the lids acts as a centering apparatus so that the lens is then returned to its true position on the cornea. In oblique positioning of the eye, a similar process occurs, with the end result that the lens is again positioned properly on the cornea.

High degrees of corneal astigmatism present no particular problem. Selection of the proper lens (see "Fitting Procedure") inside curve will provide a sufficiently thick tear layer so that the lacrimal lens is adequately spherical for the corneal lens to maintain a good lens-cornea relationship.

FITTING PROCEDURE

Before fitting the lens, the examiner must be certain that the cornea is free from active pathology. The lens is contra-indicated in such cases. Slit lamp bio-microscopy, fluorescein instillation and careful external examination (oblique illumination, etc.) will reveal the condition of the cornea.

The most important concept in fitting the corneal lens is that there must exist a definite relationship between the curvature of the inside surface of the lens and the cornea. The radius of curvature of the inside curve of the lens must always be longer than the longest radius of the cornea so that the lens rests closer to the corneal epithelium at the apex than at the periphery, with consequent formation of a minus lacrimal lens. The following presents merely the steps in the fitting technique; a detailed explanation with appropriate diagrams follows under the section titled: "Discussion."

Fitting Technique:

1. The Spectacle Prescription:

   Obtain the spectacle prescription by ordinary refractive means. Transpose to minus cylinder form.

2. Vertex Distance:

   In spectacle corrections below plus or minus 5.00 D., the vertex distance may be disregarded.

   In spectacle corrections above plus or minus 5.00 D., measure the vertex distance in any convenient manner. The following is suggested:

a—With stenopaic slit in phoropter or trial frame, have patient close eyes. Insert metal mm. rule through slit to point of contact on patient's closed lid. Add 1 mm. for lid thickness.

b—Estimate vertex distance by using calibrated slot on temporal side of phoropter or trial frame.

3. Ophthalmometer Reading:

Careful ophthalmometer readings should be taken. If doubt exists, the reading should be repeated three times and the mean average recorded of the meridians of most power and least power.

4. Indicated Corneal Lens:

The lens is available in 27 stock inside radii of curvature titled Series I to and inclusive of Series XXVII in steps of 5/100 mm. Series I has a radius of 7.50 mm., Series II a radius of 7.55 mm., etc., up to Series XXVII, which has a radius of 8.80 mm. The greater the Series Number, the longer the radius of curvature, and the flatter the inside curve of the lens.

A series of tables have been devised to arrive quickly at the required lens after taking the measurements of (1), (2) and (3) above. This avoids the necessity of trying the entire stock series of lenses before achieving a satisfactory lens-cornea relationship.

The indicated lens will have an inside radius of curvature which is approximately 3/10 mm. longer than the longest radius of curvature of the cornea.

In practice, three pairs of lenses are ordered: the first pair as indicated by measurement, a second pair whose inside radius is 5/100 mm. shorter than the indicated lens, and a third pair whose inside radius is 5/100 mm. longer than the indicated lens. This is necessary because of the variability of the optimum relationship for each individual case.

5. Preparation of Lens Before Insertion:

The lens chosen must be cleansed and wetted thoroughly with any accepted germicidal wetting agent. Barnes-Hinds wetting solution has been found satisfactory. The wetting agent should then be carefully and thoroughly rinsed from the lens with distilled water or tap water.

6. Insertion of Lens:

No suction is required with the suction cup, the lens merely resting on the moistened cup. The patient is instructed to fixate straight ahead. If the practitioner is right-handed he stands at the right side of the patient. The left hand is placed over the frontal area of the patient's head such that the index and middle fingers of the left hand are used to retract the upper lid. The wetted lens resting on the suction cup is approached to the eye, the suction cup being held between the thumb and index finger of the right hand. As the lens nears the eye, the middle finger of the right hand pulls the lower lid down, the lens is approached near the cornea and the suction cup is squeezed. This expels the lens and it drops on the cornea. The insertion must be performed with gentleness and finesse. The patient is naturally apprehensive over the introduction of a foreign body into the eye. Control of the lids by the practitioner is most important, for the patient will involuntarily attempt to blink, which may force the lens out of the eye before it is in place, or may add to the patient's initial discomfort by the lids spasmodically clamping down on the lens. The lids should not be permitted to close without control and support of the fingers.

The patient should be fixating downward before the lids are released. The lower lid is permitted to assume its normal position first. By means of the lower lid, the lens should be moved upward so that it overlaps the superior border of the cornea before the upper lid is released. This serves to minimize the irritation of the upper lid passing over the border of the lens. The patient is instructed to continue fixating downward since this position is most comfortable and will allay continued apprehension.

7. Gross Examination of Lens-Cornea Relationship:

At first excessive lacrimation will occur and the patient will complain of discomfort beneath the upper lid. Allow a few minutes for the patient to become accustomed to the new sensation. Then, with the patient fixating straight ahead, retract both upper and lower lids with the fingers. The lens by this time should have assumed a position such that its upper border is situated slightly above the superior border of the cornea.

The lens is first moved upward by digital pressure on the lower lid, and then downward by manipulating the upper lid downward. The movement of the lens should be free. After observing the movement of the lens, in all cases, release the lower lid first and only after the lens has moved upward slightly beyond the limbal margin may the upper lid be released. If the movement is free, and the patient is comfortable except for foreign body sensation referred to the lids, the lens is to be left in place for one-half hour.

If the movement is sluggish, this lens is to be removed and the next flatter lens (higher series number) i.e. lens with 5/100 mm. longer radius of curvature on its inside surface, is to be inserted.

If the movement is excessive, this lens is contra-indicated and the next sharper lens (lower series number, i.e. lens with 5/100 mm. shorter inside radius of curvature) is to be inserted.

8. Wearing Time:

On the second day, the favorable lens is to be inserted and worn for two hours. The movement of the lens should be checked every half hour. If the indications are unfavorable, that lens should be removed and another lens inserted as indicated (see #7).

On the third day, the patient is taught to insert and remove lenses, and is to wear the lens in the office for two to three hours. If the lenses have proven satisfactory, the patient is allowed to take possession of the lenses with the warning that they must not be worn in excess of two hours each day. The patient is instructed to return in a week.

9. Secondary Manifest Refraction:

If, after a week, the patient reports comfort with the lenses, and a check of the cornea shows no disturbances, a secondary refraction is performed with spheres only, as the corneal lens does not lend itself to the grinding of a cylinder. If lenticular residual astigmatism is present, it cannot be corrected by the corneal lens. However, it has been found that in most cases with residual astigmatism, the uncorrected astigmatic error becomes less as the lens is continuously worn and does not disturb the visual acuity to an objectionable degree. The refractionist can so position the astigmatic line focus by means of spheres only that the retina is midway between the focus of the meridian of least power and the focus of the meridian of greatest power which will give the patient best possible visual acuity.

10. Increasing Tolerance:

From here on a slow and steady increase in the wearing time is to be acquired by the patient. A good plan is to increase the wearing time one-half hour per day, PROVIDED NO OBJECTIONABLE SYMPTOMS OCCUR, until the patient can wear the lens as long as desired. Complete control should be exerted over the patient by requesting appointments for progress reports at the discretion of the refractionist.

11. Patient's Technique:

The patient does not use a suction cup with the corneal lens.

The lens is prepared prior to insertion by washing thoroughly with a germicidal wetting agent; the wetting agent is then completely rinsed from the lens with tap water. For right eye insertion, the lens is placed (ocular side up) on the tip of the index finger of the right hand. The left hand comes across the face, and the lids of the eye are separated widely by means

Fig. 5. Patient inserting corneal lens.

of the index finger of the left hand (for upper lid) and the thumb of the left hand (for lower lid), the separating fingers approximating parallelism. The head is inclined horizontally facing the floor. The right index finger (on which the lens rests) is raised to the eye with the patient fixating the lens as it approaches the eye. The lens is inserted with no pressure and will assume its natural position on the cornea. The patient keeps the lids separated for a few moments after the lens is in position on the cornea. In the event that the lens is placed on the sclera, the patient separates the lids as above, rotates the eye in a complete circular motion to the limit of its excursion in every meridian and then blinks. If the lens is still decentered,

Fig. 6. Patient removing corneal lens.

the patient repeats this procedure with the result that the lens will either center itself properly on the cornea or fall out of the eye. Insertion technique for the left eye is similar to that for the right eye but with reversal of hands.

For right lens removal, the head is inclined horizontally facing the floor. The patient widens the palpebral fissure with the lid and facial muscles without help from the fingers, as if expressing great surprise. The index finger of the right hand is placed at the temporal canthus, and the outer angle of the eye is displaced temporally as the finger pulls outward and slightly upward, the patient maintaining the wide-eyed expression. The lens will then fall from the eye and is to be caught by the left hand cupped under the eye. The left lens is removed by a similar technique with reversal of hands. The modus operandi for removal is as follows: When the palpebral aperture is widened as illustrated, the edges of the lens (both superior and inferior edges) are contacted by the upper and lower lid margins. As the external canthus is displaced laterally, the margins of the lids grasp the edges of the lens and move it temporally off the cornea. There now exists a relatively large air space between the temporal edge of the lens and the eye. This air space abolishes the surface tension and the lens falls out of the eye by force of gravity.

DISCUSSION

Practitioners soon learn that patients do not fall into the neatly, clearly defined categories presented in the textbooks. This discussion will clarify the recognition and handling of cases in general, with emphasis on subjective symptoms and objective signs.

SUBJECTIVE SYMPTOMS

The cardinal subjective symptoms are: (a) lid sensation, (b) stinging and burning, (c) lacrimation, and (d) corneal fogging.

Lid sensation is a natural and expected symptom. The lids in general develop a tolerance to the lens as explained under "Physiological Concepts." Usually there is a foreign body sensation referred to the upper lids, and the lids may feel hot. These symptoms disappear on removing the lens. This is merely a stage of discomfort through which the patient must progress until the point is reached where these lid sensations tend to disappear.

Stinging and burning represent a condition that must be corrected. Should this symptom occur immediately after introduction of the lens, it is generally caused by incomplete rinsing of wetting agent, or incompatibility between eye fluids and rinsing agent. In either case, the lens should be removed, thoroughly rinsed and reinserted. If the stinging and burning still persist, the lens is to be removed again, and the patient instructed to blink several times, and the lens is to be reinserted. This procedure usually abolishes the symptom.

Extensive lacrimation occurs when the lens is applied for the first time. On successive trials the lacrimation subsides. When the initial sensations are comfortable and continue as such for some time, at the end of which a sensation of stinging and burning and tearing occurs,

the relationship of lens to cornea is incorrect. This stinging and burning indicates a disturbance of the metabolic processes beyond the ability of the organism to compensate for same. The patient should not be asked to tolerate this condition, and the practitioner must make the changes as indicated (See "Objective Symptoms") so that a satisfactory lens-cornea relationship is achieved.

Corneal fogging may be recognized by the patient in its incipiency by observing a light. It will typically be surrounded by a misty halo at the periphery of which may be seen the colors of the spectrum arranged concentrically. If the exciting cause is not removed, vision will become progressively worse with objects in space apparently obscured by a thick mist. If at any time during the fitting procedure, the patient reports fogging, a careful check of the lens-cornea relationship must be made and correction of the condition accomplished.

Because of the complexity of the subject, the writer will digress temporarily to mention briefly the physiological theory for fogging as applied to the poorly fitted corneal lens.

The cornea is composed of about 80 per cent water, the balance being proteins and various salts. An increase or marked decrease in the amount of water is associated with loss of transparency of this structure. The maintenance of this transparency is one of the important functions of the corneal epithelium and endothelium. The integrity of the epithelium depends on a supply of oxygen (derived from aqueous and atmosphere by means of tears), and an uninterrupted supply of trophic impulses from its nerve (1st division of Fifth Cranial Nerve—The Trigeminus).

The cornea obtains its nourishment by diffusion from the vascular plexus around the limbus or from the fluid in the anterior chamber. Normally when the epithelium and endothelium are intact, the cornea allows water, salts, drugs and oxygen to diffuse slowly from without inward. Partial destruction or a break in the continuity of the epithelium will allow more rapid diffusion inward. The normal metabolism, permeability and physico-chemical activity of the epithelium is controlled by the function of the trigeminal nerve. After nerve irritation, the amount of water in the epithelium increases.

Therefore a clouding of vision due to changes in the corneal tissues can be attributed mainly to a change in the amount of water in the corneal cells due to imbibition or change in the osmotic flow, asphyxia, accumulation of carbon dioxide or some other disturbance in normal metabolism due to undue pressure at the limbus, or on scleral and conjunctival vessels or on the corneal and scleral nerves.

OBJECTIVE SIGNS

A basic tenec in corneal lens philosophy is that at no point must there be continued contact with the eyeball; continuous circulation of the tears must be uninterrupted. By the same token, continuous pressure on the cornea, or on the sclera in the sulcus area will, per se, cause a disturbance in the normal metabolism of the cornea. *The lens must ride freely on the pre-corneal film bathing the cornea.* The practitioner may determine the quality of the lens-cornea relationship by the lens position, lens movement and presence of bubbles.

The position which the lens assumes is observed with the eyes of the patient in the primary position when both lids are retracted by the fingers. The superior border of the lens should be positioned at the limbus or not in excess of 1 mm. above the limbus. An analogy here may be drawn regarding the inside curvature of the lens, for the lens, like water, seeks its own level, i.e. a curvature of similar degree (but opposite in character) to its own. A lens will position itself as high on the sclera of the eye as the point on the sclera where the bevel angle of the lens is no longer compatible with the curvature of the sclera.

The movement of the lens is instigated, after retraction of the lids by the fingers, by digital manipulation of the lower lid (which moves the lens up) and of the upper lid (which moves the lens down). The movement should be free, but not excessively so. The closer the inside radius of the lens approximates that of the cornea, the less the movement of the lens; the greater the disparity between the inside radius of the lens and that of the cornea, the more free will be the movement of the lens. At the same time, observation is made as to the degree of lateral lag of the lens from the cornea in the direction opposite to the direction of rotation, as the eye moves laterally.

Bubbles are usually not present, or if present when the lens is first inserted, they work out easily. Bubbles will be formed at the point where there exists an exaggerated space between lens and cornea.

The above mentioned characteristics (position, movement, bubbles) are controlled at any given time by changes in the inside curvature of the lens (Series Number), or in the diameter of the lens (small, regular, large). Since these factors are basic in the successful fitting of the lens, the writer will discuss each in some detail. In the following, the term, "too sharp," is used whenever any given lens is too closely related to the curvature of a cornea; "too flat" is used whenever any given lens is too loose in relation to the curvature of a cornea.

Inside curvature of lens.

To demonstrate the effect of Series Number (inside curvature of

the lens) only, the influence of the lids is purposely omitted. Without the presence of the lids, these diagrams necessarily become hypothetical, but they should help in the understanding of the overall fitting problem. In observing these sketches, the reader's indulgence is requested for the liberties taken in proportion, in order to emphasize the principles illustrated. The influence of the lids will be explained fully in the discussion on "Diameter of the Lens."

OPTIMUM FIT

In this instance, the inside curvature of the lens bears an optimum relationship to the curvature of the anterior surface of the cornea. Figure 7.

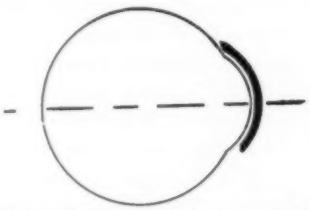

Fig. 7. Optimum fit of corneal lens. Series Number only.

1. Position: Positioning is good. With both lids retracted and the eye in the primary position, the lens is so positioned that its superior border is at the limbus, or slightly overlaps the limbus by 1 mm.
2. Movement: Movement is free but not excessively free as induced by digital pressure alternately on the lower and then the upper lid. Lateral rotation produces a slight lag of about 1 mm. in the direction opposite to the direction of fixation.
3. Bubbles: Bubbles are either non-existent, or if present upon initial insertion of the lens, work out easily after a few minutes' wear.

LENS TOO FLAT

In this instance the inside curvature of the lens bears a too loose relationship to the curvature of the anterior surface of the cornea. Figure 8.

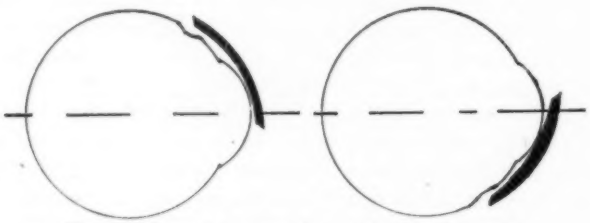

Fig. 8. Corneal lens too flat. Series Number only.

1. Position: The position assumed by the lens when both upper and lower lids are retracted and the eye fixates straight ahead is either very high or very low, dependent upon the amount of correction. In high ametropias, the weight of the lens forces it downward.

2. Movement: Movement is excessively free with both lids retracted and motion induced by digital pressure alternately on the lower and then on the upper lid, the lens falls freely and easily. Lateral rotation produces an excessive lag in the direction opposite to the direction of fixation.
3. Bubbles: Bubbles are formed where there exists the greatest depth between lens and eye, i.e. directly at the limbus or sulcus sclerae.

The correction of the condition wherein a lens is too flat and therefore too loose in relation to the cornea is accomplished by substitution of a lens which has a sharper curvature and thus a tighter relation to the cornea.

LENS TOO SHARP

In this instance the inside curvature of the lens bears a too tight relationship to the curvature of the anterior surface of the cornea. Figure 9.

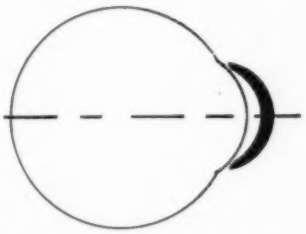

Fig. 9. Corneal lens too sharp. Series Number only.

1. Position: The position assumed by the lens when both upper and lower lids are retracted and the eye fixates straight ahead is excellent and the lens is well centered. This position compares favorably with the position of the optimum fit.
2. Movement: Movement is either impossible or excessively sluggish, with both lids retracted and motion induced by digital pressure alternately on the lower and then the upper lid. Lateral rotation produces no lag.
3. Bubbles: Bubbles are formed where there exists the greatest depth between the lens and the eye, i.e. directly in the center, or optical zone of the cornea.

The correction of the condition where a lens is too sharp and therefore too tight in relation to the cornea is accomplished by substitution of a lens which has a flatter curvature and thus a looser relation to the cornea.

DIAMETER OF THE LENS

In a systematized fitting procedure, it is advisable to first determine that the lens-cornea relationship is optimum considering the Series Number (inside radius of curvature) only. When this has been determined as correct, the practitioner can then consider the influence of the diameter on the quality of the fit as a whole. Failure to observe this system will only result in frustration to both doctor and patient, and will cause changing lenses continuously for no logical reason. All of the

following remarks are predicated on the assumption that a satisfactory lens-cornea relationship as determined by Series Number has already been established.

The corneal lens is available in three diameters: small, regular and large. The factors controlling the diameter of the lens are the apparent iris size and the size of the palpebral aperture.

Apparent iris size: The diameter of the lens should be small enough to fit within the horizontal limits of the apparent iris with the eye in the primary position. However, the lens should be of sufficient diameter to adequately cover the pupillary aperture.

The palpebral fissure may be considered the more important factor. It will be recalled from the section on "Physiological Concepts" that when the eye is open and in the primary position, the upper lid just covers the upper 1/5 of the cornea while the lower lid is just free of the lower border of the cornea. Usually very little or no sclera shows between the inferior limbus and the lower lid under these circumstances. This may be considered a normal aperture, and in most cases the regular diameter would suffice. Variations from the normal aperture could be present as follows:

a. Upper lid covers considerable portion of superior cornea.
b. Appreciable portion of inferior cornea is covered by border of lower lid.
c. Considerable sclera shows between inferior limbus and border of lower lid.

These conditions do not necessarily require variations from regular lens diameter. In general, however, the wider the palpebral aperture (with the eye in the primary position) the greater the diameter of the corneal lens. Conversely, the smaller the palpebral opening with the eye in the primary position, the lesser the diameter of the corneal lens.

To determine the effect of lens diameter on the lens-cornea relationship, lens position and lens movement are considered.

Lens position is observed with the eye of the patient in the primary position. The superior border of the lens should be positioned so that it is covered by the upper lid approximately in the same fashion as the cornea. If the upper lid be retracted momentarily, moderate but not excessive indentation of the superior sclera in the sulcus region is seen. The inferior edge of the lens should just contact the border of the lower lid, or be positioned not more than 1 mm. above the lower lid margin. The lower lid supports the lens and in the primary position does not permit the lens to pass beneath it.

Lens movement is observed concomitantly with the blink of the upper lid while the eye is in the primary position. In the act of blinking, as the upper lid descends it cups the lens and may move it downward. As the upper lid rises, it carries the lens to a relatively high posi-

tion, whence the lens by force of gravity drops to the border of the lower lid. The observer notes the relative distance the lens traverses as it drops to the border of the lower lid.

In the following illustrations, it is assumed that the proper lens-cornea relationship (as determined by the inside curvature of the lens, i.e. Series Number) has already been established.

OPTIMUM DIAMETER

In this instance the diameter of the lens bears an optimum relationship to the palpebral aperture. Figure 10.

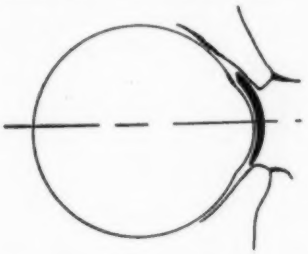

Fig. 10. Corneal lens. Optimum diameter.

1. Position: Positioning is good, for with the eye in the primary position, the lens is so situated that its superior edge is covered adequately by the upper lid. If the upper lid be retracted momentarily, moderate indentation of the superior sclera in the sulcus region is seen (moderate indentation denotes a gentle pressure of the lens insufficient to obliterate the blood vessels passing beneath the edge of the lens). The inferior edge of the lens just contacts the border of the lower lid.

2. Movement: With the eye in the primary position, the patient is instructed to blink several times. At the conclusion of each blink, the amount of movement evident when the lens settles to the point of contact with the lower lid is observed. The lens moves approximately 1 mm. downward, which is a desirable, adequate movement.

DIAMETER TOO LARGE

In this instance, the diameter of the lens bears a too large relationship to the palpebral aperture. Figure 11.

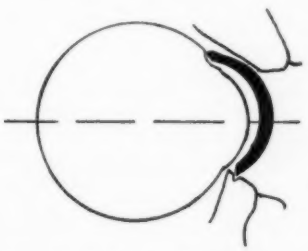

Fig. 11. Corneal lens. Diameter too large.

1. Position: With the eye in the primary position, the lens is so situated that a considerable part of its superior portion is covered by the upper lid. If the upper lid be retracted momentarily, excessive indentation by the lens of a relatively large amount of superior sclera in the sulcus area is seen with consequent obliteration of scleral vessels at the point of contact beneath the lens. The inferior edge of the lens depresses the border of the lower lid.

2. Movement: With the eye in the primary position, the patient blinks several times. The pressure exerted by the lens depresses the lower lid and the opposing resistance of the lower lid holds the lens in a stationary position against the superior sclera. Therefore, the lens exhibits little or *no movement* despite the blinking action of the upper lid.

DIAMETER TOO SMALL

In this instance the diameter of the lens bears a too small relationship to the palpebral fissure. Figure 12.

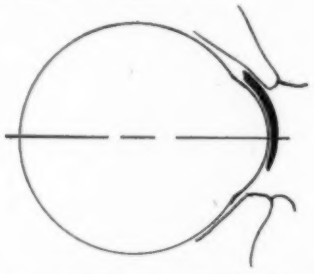

Fig. 12. Corneal lens. Diameter too small.

1. Position: With the eye in primary position, and provided that a satisfactory lens-cornea relationship as determined by the Series Number has already been established, the lens is so situated that its superior edge is covered adequately by the upper lid. If the upper lid be retracted momentarily moderate indentation of the superior sclera in the sulcus region is seen. This lens feigns the optimum diameter except that the lower edge of the lens is seen *markedly* elevated above the border of the lower lid.

2. Movement: With the eye in the primary position, the patient blinks several times. In blinking continuously, the anterior surface of the lens becomes well lubricated with eye fluids. Under these circumstances, the upper lid can retrieve the lens but cannot hold it because of the increased lubrication. With each blink, *excessive movement* is noted as the lens settles rapidly downward to the level of the lower lid margin and marked tapping of the lens against the lower lid border is noted at the conclusion of each blinking movement.

DIAMETER—SERIES NUMBER RELATIONSHIP

It will be remembered from the section on "Physiological Concepts" that only the central or "optical zone" of the cornea is normally almost spherical, while toward the periphery the cornea becomes flattened. Therefore when the diameter is such that a larger lens diameter is indicated, the next higher Series Number (flatter lens) must be used as the lens will now cover an area of the cornea which is more peripheral, and therefore flatter. The converse is true when a smaller lens diameter is indicated. This observation is substantiated by the fact that a lens too large in diameter will have the appearance of a lens too tight in

relation to the cornea, while a lens too small in diameter will have the appearance of a lens too loose in relation to the cornea.

MISCELLANEOUS NOTES

Keratoconus

Conical cornea presents a rather special problem in that adequate ophthalmometer readings are impossible and the spectacle prescription has no relation to the final corneal lens prescription. A special fitting assortment is available for this condition which emphasizes the lenses with inside curves of shorter radii. A trial and error procedure is necessary utilizing the principles described in the sections on "Fitting Procedure," "Inside Curvature of Lens," and "Diameter of Lens" with particular attention given to the bubble formation. A properly fitted corneal lens in cases of keratoconus should appear well centered with relation to the apex of the cone. Usually the apex of the cone is lower than the center of the pupil. Therefore, the lens will position itself lower on the cornea than normally. If the apex of the cone is nasal or temporal to the pupillary center, the properly fitted corneal lens will assume a position nasal or temporal to the center of the pupil as determined by the situation of the cone. Usually an intermittent bubble will form behind the lens above the pupillary margin. This bubble should not interfere with vision and indicates the greatest depth between lens and cornea. The grossness of the cone determines such separation between lens and tear layer as to its extent. However, the bubble should circulate freely with the eye movements and blinking of the lids. If the bubble remains entrapped, the indication is that the lens is too sharp (too low a Series Number). Figure 13.

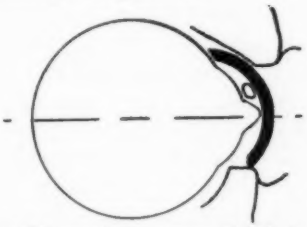

Fig. 13. Corneal lens. Keratoconus. Bubble in lacrimal lens.

Frequent installation of fluorescein and inspection with the slit lamp should be made as these cases may be predisposed to suffer abrasions at the apex.

NEW PLASTIC

The surface tension of methyl methacrylate is such that the plastic

must be thoroughly wetted with a suitable wetting agent before insertion. Occasionally (particularly with a new lens inserted for the first time) a lens only partially wetted will cause visual disturbances because it is then impossible for the tear fluid to be distributed smoothly over the surface of the lens. The resulting visual disturbance is purely mechanical. The anterior surface of the lens being poorly wetted prevents smooth distribution of the secretions spread over it by the lid in blinking. The resulting mechanical haziness causes poor vision.

POWER OF LACRIMAL LENS AS ADDITIONAL CRITERION OF LENS-CORNEA RELATIONSHIP

As discussed under "Optical Concepts," the dioptric value of the lacrimal lens is determined by the curvature of the posterior surface of the corneal lens. If the lens presents too loose a lens-cornea relationship, its inside curvature is relatively flat so that in comparison with the lacrimal lens formed in the optimum fit, there exists a relatively lesser convexity of the thin tear layer resulting in higher minus power of the lacrimal lens. Consequently, for any given prescription, the anterior surface of the corneal lens would, of necessity, require greater convexity to overcome the increased minus of the lacrimal layer and attain the given effective correction. When the corneal lens requires plus power much in excess of that expected, the indication is that the lens has too flat a relationship to the cornea. The converse is also true.

REMOVING TIGHT LENS

If a lens presents too tight a relationship to the cornea, removal may become difficult. For this reason it is advisable during the fitting to check the lens-cornea relationship within a few minutes after insertion as mentioned in the section on "Fitting Procedure." A lens which has an inside curve too sharp in relation to the curvature of the cornea may on insertion simulate a lens of optimum relationship because of the excess fluid present. After a short interval, when this excess fluid is no longer present, the lens will exhibit its true relationship to the cornea. If the lens has apparently a too tight relationship and offers marked resistance to removal, the patient is directed to fixate downward and the superior edge of the lens is tilted outward away from the cornea by means of the suction cup. The air space thus created abolishes the surface tension and the lens is easily removed.

HEAD POSITION

When inserting the lens, particularly in the initial fitting procedure, the head of the patient should be in a slightly reclining position for

the patient finds downward fixation most comfortable. Objects situated at the eye level are seen with the eye fixating downward when the head is so inclined. However, *in all cases* while examining the quality of the lens relationship, the head should be in an upright position and the eye situated in the primary position. The criteria postulated in this paper require such standardization.

PROBLEMS IN APPARENT PARADOX

1. Loose Fit and Tight Fit:

Problem: The recommended lens for a cornea of 7.4 mm. radius of curvature in the meridian of least power is Series V. In trying the three lenses indicated, e.g. Series IV, V and VI, all appeared objectively tight in relation to the cornea accompanied by subjective symptoms of stinging and burning, after wearing one hour. It was necessary to progress to a Series IX before the relationship appeared definitely loose. However, the subjective symptom of stinging and burning remained even with this lens. Subsequent trials with Series X, XI and XII also resulted in the symptoms of stinging and burning.

(a) Why should it be necessary to deviate so far from the recommended lens before adequate looseness is achieved in the lens-cornea relationship?

(b) Why should lenses obviously loose in appearance cause disturbance in the corneal metabolism?

Solution: (a) All of the lenses including the recommended lenses were too loose, not too tight. The practitioner should have progressed to corneal lenses of sharper rather than flatter radii. The corneal lens will tend to situate itself in apposition with a curvature which is compatible to its own inside curvature, i.e. approximately the same curvature but opposite in character. A lens whose inside curvature is too flat in relation to that of the cornea will tend to position itself relatively high on the sclera as it is more compatible with the flatter curvature of the sclera than with the sharper curvature of the cornea. Had the practitioner made a more careful observation he would have determined that once the lenses were set in motion, all the lenses would have exhibited very definite signs of looseness.

(b) A lens whose inside curvature is too flat in relation to the curvature of the cornea will tend to position itself relatively high on the sclera. A lens of such relationship will markedly indent the sclera and exert relatively great pressure on the sclera at that point. It will be recalled from the section on "Subjective Symptoms" that a disturbance in the normal metabolism of the cornea may result from pressure on the scleral nerves and vessels.

2. Diameter Influence:

Problem: The recommended lens for a cornea of 8.25 mm. radius of curvature in the meridian of least power is Series XXII. In trying the three lenses indicated, e.g. Series XXI, XXII and XXIII, all evidenced definite objective signs of looseness, accompanied by the subjective symptom of upper lid irritation, more pronounced upon blinking. There was no stinging or burning. In attempting to achieve a tighter lens-cornea relationship Series XX, XIX and XVIII were used, but these lenses also gave objective appearance of looseness. It was necessary to use Series XVII before relationship of lens to cornea appeared satisfactory objectively. However, subjectively the XVII lens is quite irritating with the additional symptoms of stinging and burning also present after wearing for one hour.

(a) Why should it be necessary to deviate so far from the recommended lens before adequate tightness is achieved?

(b) Why should lenses adequately tight in appearance cause upper lid irritation together with stinging and burning?

Solution: (a) All the lenses including the recommended lenses were too small in diameter, not necessarily too loose. The practitioner should have progressed to lenses of larger diameter and of one Series greater, i.e., flatter curvature, as explained in the section on "Diameter of the Lens." A lens too small in diameter, even if it demonstrates

an optimum lens-cornea relationship based on Series Number only, is free to float on the tear fluids over the entire surface of the cornea, thus simulating a loose lens. Had the practitioner made a more careful observation using the criteria postulated in the section on "Diameter," he could have determined that the lenses were too small in diameter.

(b) A lens whose diameter is too small for a given palpebral fissure will give the subjective symptom of upper lid irritation. This occurs because the margin of the upper lid contacts the upper border of the lens, particularly in the act of blinking. For this reason, all lenses used on this patient caused upper lid irritation. A lens which has an optimum lens-cornea relationship will not cause stinging and burning. In the mistaken conception of attempting to correct an apparently too loose lens, this practitioner had progressed to a point where the lens relationship as determined by Series Number was too tight. This of course caused the stinging and burning.

CONCLUSION

1. The corneal lens, a prosthetic device representing a significant contact lens advancement is added to the armamentarium of the refractionist.
2. The corneal lens is superior to the conventional contact lens in respect to: comfort, corneal fogging, insertion and removal, fitting technique, thinness and lightness of weight and appearance on the eye.
3. The corneal lens is contra-indicated in the following:
    a. Active corneal pathology.
    b. Poor patient cooperation.
    c. Those conical corneas predisposed to apical abrasion.
    d. Where appreciable degrees of residual astigmatism cause persistent visual acuity diminution.
    e. Where appreciable degrees of prism are required.
4. Comprehension of basic principles, patience and persistence on the part of the practitioner, full cooperation on the part of the patient are requirements for success.
5. Other factors being equal, there is no limit to the potential wearing time.
6. A statistical approximation of those patients wearing the lenses may be stated as follows:
    30 to 40% wear the lenses all their waking hours.
    30 to 40% have a limited wearing time of five to ten hours.
    30 to 40% are in the process of increasing wearing time.
    3% of those fitted are conical corneas of whom 96% wear their lenses all their waking hours.
7. Further research is indicated.

ACKNOWLEDGMENT

The writer has spent several months familiarizing himself with the corneal lens, and observing the reaction of the corneae of hundreds of patients referred by doctors throughout the country, at the Solex Laboratories in Los Angeles, where he was tendered complete cooperation by the inventor of the lens, Kevin M. Tuohy, A.B., College of Medical Evangelists, Los Angeles, to whom full acknowledgment is given for invaluable assistance in the preparation of this article.

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ABSTRACTS

PATHOGENESIS OF MYOPIA. A new classification. Frederick C. Stansbury. Archives of Ophthalmology. 39.3.273-299. 1949.

The lack of agreement in many of the current theories on the cause of myopia and the lack of a generally accepted classification of myopia are serious obstacles to the progress of further study. The author presents an excellent summary of much of the worthwhile literature on myopia, citing over one hundred references, and he offers a classification of myopia which by further study may be able to provide information about the pathogenesis of myopia.

A brief historical survey of the early views on myopia includes Donders' five causes (excessive convergence, excessive accommodation, heredity, increased intraocular pressure, and congestion of the coats of the eye) which have been accepted—in one form or another—by most subsequent writers. Further additional causative factors which are reviewed include: shortness of the optic nerve, congenital deficiency of the sclera, growth disorder, extra-ocular muscle anomalies, psychic factors, endocrine dysfunction, avitaminosis, and constitutional disease.

More recent studies, especially statistical surveys, have indicated that much of myopia can be considered as a biological variation of the normal. Stansbury finds objection in examining critically the theories which assume axial elongation of the eye to be the paramount pathological basis of myopia. The work of Steiger and Tron by demonstrating that the occurrence of refractive errors of moderate degree may arise by the association of chance variations of axial length, corneal and lenticular refractive power, has shown that the single factor of axial length is practically insignificant in myopia of medium and low degrees.

The characteristic pathological changes seen with myopic eyes of high degree has been considered by some authorities to be a result of elongation of the globe, while others have maintained that these pathological changes are the result of a primary inflammatory process. Stansbury discusses these changes and their significance in relation to the myopia problem and he is inclined to favor the view that an inflammatory choroidal process is responsible primarily for the retinal and vitreous anomalies. He believes that scleral thinning is secondary and results in elongation of the globe from which, in turn, arise further secondary effects.

Stansbury concludes that myopia should be classified, if only to provide a working hypothesis, as follows: (1) Primary, or physiological, a biological variation in healthy eyes; and (2) Secondary, or pathological, distinguished by the presence of pathological fundus changes.

He contends that by employing this classification further statistical study may be able to provide valuable information about the causation of myopia where other methods have failed.

Optometrists would be well advised to read this excellent paper, and those who write or lecture about myopia would do well to try to emulate the thorough and unbiased treatment of this important subject as presented in this paper.

R. E. B.

OBJECTIVE AND SUBJECTIVE MEASURES OF NIGHT MYOPIA*

EFFECTS OF DARK ADAPTATION AND PRELIMINARY EXPERIMENTS

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As time is reckoned in scientific progress night myopia is a very recent discovery. The fact that individuals become relatively myopic at night or when the brightness level drops to the point where scotopic vision replaces the photopic counterpart has been known less than a decade, references to the phenomenon appearing in the European scientific literature from time to time since 1941.[1,2] American investigators, among them Tousey[3] and Wald[4], have also found this subject of great interest. Many theories as to the cause of nocturnal myopia have been advanced. It is generally explained by the simultaneous intervention of, on the one hand, the Purkinje phenomenon together with the chromatic aberration of the eye, and in the other, of ocular spherical aberration. The first factor accounts for about three or four tenths of a diopter and the second for most of the balance up to a probable maximum of 1.7 diopters. Other factors such as the Stiles-Crawford effect, considerable decrease of contrast sensitivity, poor image formation by the rods, all play a part, however.

The purpose of this paper is to announce two methods for the investigation of night myopia. While various techniques have been used, they appear to be uniformly deficient in one respect. In almost every case concave lenses or negative optical effectivities are used. Thus we are left wondering whether night myopia actually exists or is an artifact introduced by creating an artificial hyperopia with, therefore, a stimulation of accommodation which improves vision by eliminating positive spherical aberration. The question remains as to whether the ocular image is actually in front of the retina, or whether artificial hyperopia produced in the testing situation is the agent of improvement in clarity of a poorly defined retinal image, thus simulating myopia.

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In short, are we correcting a true nocturnal myopia by the application of a concave lens, or by making a reduced positive or increased negative setting, optically, of the testing device? Or are we introducing an artificial hyperopia which when compensated offers more distinct vision at low brightness levels? It must be remembered that the visual situation at night differs from that during the day time. Under photopic conditions, because of high contrast sensitivity, spherical aberration does not greatly affect clarity of the retinal image. Moreover, the central part of the pupil is used and cones carry the burden of image formation. However, under scotopic conditions spherical aberration obscures the faint retinal image, both central and peripheral parts of the pupil are used, and differential sensitivity of the retina is considerably reduced.

Accommodation reduces or eliminates positive or undercorrected spherical aberration. For example, Ivanoff[5] states that it is necessary to accommodate about 1.5 D. in order to disembarrass the retinal image of spherical aberration. He claims that the ocular image is in place on the retina but that a concave lens is necessitated for the sake of creating this added accommodation. He therefore believes night myopia is incorrectly termed since it is not a true myopia but simulates it.

In any case it seems advisable to use techniques in which the use of negative optical effectivities is obviated. One such method is skiascopy. Immediately, however, the objection is made that the intense white light of the retinoscopic beam would eliminate night myopia by changing the state of adaptation of the retina, raising the brightness level, constricting the pupil and hence changing the degree and perhaps the type of spherical aberration. It is true that such is the case. However, the writer[6] eliminated these difficulties by employing pure deep red light for skiascopy by the use of appropriate filters attached to his retinoscope. The use of a red beam has several advantages. First, pure red light has no effect on the pupillomotor fibers and does not affect the size of the pupil; second, it is "monochromatic" and hence eliminates any myopia caused by chromatic aberration; third, because of the great difference between its effect on the rods and on the cones, it does not interfere with dark adaptation of the eye being examined, nor, as proved by tests, with its scotopic acuity, while at the same time the experimenter has no trouble in observing the retinal reflex, or shadow.

The advantage in using skiascopy for measuring night myopia is that the test is objective, and it also reveals the position of the image relative to the retina. The red filter makes possible the use of this method. Data was secured on one subject at different brightness levels

but at long intervals due to pressure of other experimental work.* This fact and the constant use of the specially constructed dark room for other purposes mitigated against the collection of more data in both sections of this experiment. Because of the difficulty of working in an almost completely dark room two experimenters were used, both proficient in the use of the retinoscope. Their findings were almost identical. In case of a minor difference the writer's findings were used since he performed the experiment during its duration.

The photopic transmission of the pure red filter used was 6.9% and its scotopic transmission 0.345%, giving a photopic-scotopic ratio of nearly 20 to 1. Its dominant wavelength was 619 mμ.

Before being dark adapted the right eye of the subject was subjected to static skiametry at normal light levels with both a white and a red beam. The difference was surprisingly small, only 0.12 D., the red beam giving the higher plus finding. After a total of 25 minutes dark adaptation, findings were secured at scotopic levels and compared with those obtained at the photopic level. Measurements were made from time to time at different scotopic levels. The subject's right eye normally manifested + 0.50 D. sph.** at the normal 20 Ft.-L. brightness level. The data are given in tabular form in Figure 1.

TABLE I

	Target Brightness Level in Foot-Lamberts	Target Distance Meters	Time Dark Adapted in Minutes	Myopia Manifested in Diopters
I	1. 20	6	0	0.00
	2. .001 (quarter moon)	6	25	0.50
	3. .00003 (partly overcast starlight)	6	25	1.00
II	1. 20	6	0	0.00
	2. .00001 (overcast starlight)	6	25	1.62
	3. .00001	3	35	1.62
	4. .00001	2	45	1.62
III	1. 20	6	0 (pupil small)	0.00
	2. .004 (half moon)	6	0 (pupil small)	0.00
	3. .004	6	4 (pupil large)	0.00
	4. .004	6	15 (pupil large)	0.37

Table 1. Effect of brightness level, adaptation time, and target distance on night myopia. Data for principal observer.

It is noted from the table that night myopia seems to increase as target brightness is reduced. At normal light levels it is zero. At 4/1,000 Ft.-L. it is 0.37 D., at 3/100,000 Ft.-L. it increases to 1.00 D.

*This study was a personal investigation while the writer was research psychologist at the U. S. N. Medical Research Laboratory, U. S. N. Submarine Base, New London, Conn. It was not related to any Navy research project and any opinions expressed here are those of the writer and not of the U. S. Navy.

**Fast "with" motion of shadow. +0.50 D.S. was revealed at point of reversal.

while at 1/100,000 Ft.-L. it measures 1.62 D. at 6 meters. Oddly enough when the distance from the target was decreased from 6 to 3, then to 2 meters, the net measurement increased. Accommodation would not relax for the added plus lenses used to compensate for vergence. The meaning of this is not clear. Perhaps the approach to the target gave an opportunity to stimulate more accommodation. It will be also noted that unless the eye is dark adapted night myopia is not manifested, even if the pupil becomes fully dilated. Hence it does not result from spherical aberration alone since pupillary size has no effect without dark adaptation.

In addition four subjects were tested with and without dark adaptation. Although their pupils were nearly fully dilated, no night myopia was manifested at four minutes. At 20 minutes, varying degrees, from 0.25 D. to 0.62 D. of night myopia resulted at 4/1000 Ft.-L. Apparently the phenomenon varies with the individual. Tousey[7] claims this is caused by individual variation in spherical aberration.

Unfortunately these four additional subjects could be tested only at one brightness level, viz. .004 Ft.-L. since the especially constructed dark room with its excellent apparatus for scotopic testing purposes was being used constantly for another experiment. The standard optometric alley was therefore provided with a low level source of illumination which, however, was not easily variable but which was used for determining the effect of dark adaptation on night myopia. Although, as stated above, the degree of night myopia varied among the four subjects, the range was narrow, i.e. from 0.25 D. to 0.62 D. The reason for this is that, granting the effect is dependent on the brightness level, its magnitude is limited here through inability to further decrease the light level. However, the results indicate that certainly the increased diameter of the pupil, even in the presence of complete darkness, is not by itself the causative agent in the onset of nocturnal myopia. The eye must not only be dark adapted but must be presented with a dim image. This is not to say, however, that spherical aberration of the under-corrected type is not concerned in the manifestation of the phenomenon.

Although the brightness of the red beam used in skiascoping all five of the subjects was not measured, it was apparently low enough not to interfere with scotopic dark adaptation. Scotopic acuity measurements were made on the principal observer during skiascopy and found to be nearly identical with those made before the examination. The acuity targets were of the checkerboard type mounted on a revolving target holder.

In order to meet any objection concerning the use of lenses in this

procedure the eye was also skiascoped without lenses. To obtain an "against" motion at the working distance of 26 inches, which we used, more than a diopter and a half of night myopia must be manifested in the case of an emmetrope. At the lowest levels, the subject being normally a hyperope of 0.12 D., this was indeed the case. A definite myopic movement of the reflex or shadow was observed without a lens. This verifies the results obtained with the use of working distance lenses. The ocular image in night myopia is apparently in the vitreous, before the retina. However, this finding does not eliminate the possibility that the eye may accommodate optimally in order to strike a balance between the two opposing types of spherical aberration, that of the crystalline and that of the cornea, thus ridding the ocular image of a distortion so harmful to its clarity under the conditions of night vision when the differential sensitivity of the retina falls to very low levels. It seems, on the contrary, to indicate that the effect is not caused by the production of an artificial hyperopia through the use of concave lenses or a decrease in convex lens effectivities. Rather, the lenses correct the condition.

Insofar as the effect of brightness level on magnitude of night myopia is concerned the writer feels that he lacks sufficient data to make a positive statement. It is his intention to continue experimental work along these lines when time permits.

In comparing the amounts of night myopia as measured in this experiment it must be borne in mind that the total effect would have been larger if monochromatic light had not been used. That part generally ascribed to chromatic aberration, about 0.3 D., must be added in order to secure an approximation of the total amount of the effect.

In analyzing the effect of target distance on the magnitude of the nocturnal increase in the total static refractive power of the eye it is noted that it seems to increase as the target is approached from 6 to 2 meters. Actually this is more odd than it appears at first glance. If the relationships between the amount of plus lens power necessary to subtract in order to correct for vergence together with the working distance subtraction, and the distance to target are studied, it is seen that the total lens power before the eye is the same at all three distances. That is, if an extra ½ D. is subtracted for the 2-meter fixation, and ⅓ D. at 3 meters, the net lens power is lower in plus and higher in minus, the more so the smaller the fixation distance. However, if we subtract only the working distance lens we end up with the same net power for all three distances. This may support, in part, Wald's[4] contention that a "fixed" focus is present in night myopia. In any event this interesting effect must be further studied.

We will now consider the second method of measuring the state of refraction of the eye under conditions of normal and low brightness levels. It is called stigmatoscopy and, like skiascopy, is based on the position of points conjugate to the retina when accommodation is relaxed as in the case of distance fixation. It is, however, a subjective technique unlike skiametry which is considered an objective test, at least insofar as the subject is concerned.

The apparatus used was an instrument, the only one of its kind, called an oculometer or stigmatoscope. It was built by the American Optical Company under the direction of vision scientists at the Dartmouth Eye Institute. We were fortunate in being able to borrow the instrument which is a type of optometer based on haploscopic principles, with several important differences, however. A pair of semi-silvered mirrors are fixed before the eyes at 45° to the visual axes, so that distance fixation is binocular with convergence fixed. The collimating lenses and stimulus targets do not interfere with distance fixation since they are placed on side-arms at right angles to the visual axes. The collimating lens is fixed but the target, a small cross, or point source, or line, or 3 dots, may be moved until it and the retina are conjugate. At this position the target, which is projected onto the visual axis of the eye being tested by means of the semi-silvered mirror, is seen as most clear by the subject who is fixating with both eyes at a distance of 6 meters. The refractive error for the meridian of the eye being tested is then read off directly, in diopters, from the scale mounted along the side arm. In similar manner the other primary meridian is measured and refraction completed.

Because of the presence of the hyperfocal interval resulting from the characteristic form of the image caustic, the refraction as compared with a subjective examination of the clinical type is more myopic or less hyperopic, to the extent of approximately one-half diopter. It is related to the depth of focus of the eye. In this study the results obtained with the oculometer were compared under normal and low level brightness conditions.

The procedure was exactly the same as that used in the skiascopic study. Pure red filters were used in conjunction with the side-arm targets. Two subjects were used. However, it was necessary to make this study in the standard optometric alley where only one low brightness level (.004 Ft.-L.) could be used. Hence it was not expected to find high degrees of night myopia. Twenty oculometric tests were made on each subject at the normal level of illumination (20 Ft.-L.) for the original targets and also for the pure red lighted targets; the

tests were then repeated after 20 minutes dark adaptation at the .004 Ft.-L. brightness level. Both eyes were thus examined. The results follow:

Subject D, right eye difference between original (impure green) and red stimulus targets was 0.384 D. (more plus for the red); left eye difference, 0.341 D. In subject S these differences were respectively 0.388 and 0.358 Diopters.

The amount of night myopia revealed at .004 Ft.-L. was:

Subject D: Right eye = —0.174 D., Left eye = —0.277 D.

Subject S: Right eye = —0.066 D., Left eye = —0.072 D.

These results indicate a smaller night myopia by the oculometric method than that found through use of the skiascope at the same light level. Comparisons were made using only the skiascopic test results obtained under the same conditions as the oculometric ones. Obviously, neither included night myopia caused by chromatic aberration.

Possible reasons for the small degree of night myopia measured by this technique are:

1. The scotopic testing level was not low enough and hence limited the size of the effect.

2. The depth of focus may differ in range under the two conditions, and hence the hyperfocal interval may "cut across" the results. Were there no hyperfocal interval at night, or were it decreased considerably, the oculometer would give a finding correspondingly lower than the actual amount. The writer believes that this factor is operative in the causation of night myopia.

The writer has presented two techniques for the study of night myopia in order to eliminate some of the confusion still extant. He feels they are effective and offer possibilities. It is only necessary to procure more data, keeping in mind also the necessity of constantly improving a technique, or altering it to study a particular factor. Insofar as the data are concerned this paper must be considered a preliminary report.

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VARIATIONS IN VISUAL ACUITY OF A GROUP WITHOUT MAJOR REFRACTIVE ERRORS*

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The purpose of this study was to determine the nature of the variation in visual acuity in a group without major refractive errors. Visual acuity, as defined in this paper, is a size measure of performance in perceiving form based on the smallest checkerboard of the acuity slides of the ortho-rater correctly identified.

PROCEDURE

It was decided to establish the criterion of major refractive error as three quarters of a diopter or more astigmatism, myopia, or hyperopia. This error was determined in each case by a professional optometrist performing a retinoscopy.‡ The subjects who were found free from major refractive errors were then tested on the Ortho-Rater following standard testing procedure on all tests except the monocular acuity tests. These four tests; F-4 (far right eye acuity), F-5 (far left eye acuity), N-2 (near right eye acuity), N-3 (near left eye acuity) were administered occluded. It was thought that this technique would minimize problems of ocular dominance and retinal rivalry.

The subjects were students in an elementary psychology class in Purdue University. Of the group tested, 57 subjects met the criterion of freedom from major refractive errors. This group was composed of 41 males and 16 females. Age of the subjects ranged from 17 to 28 years with a mean age of 21.4.

RESULTS

Means, standard deviation, standard errors of the mean, and ranges of scores were obtained on all six acuity tests. These are presented in Table I.

It should be noted in interpreting these data that the targets in the ortho-rater vary in physical dimensions so that a score of "8" covers a continuum from 8.00 to 8.99.

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*Submitted on December 22, 1949, for publication in the February, 1950, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Member of faculty, Ph.D.
§Graduate student.
‡The authors wish to thank Dr. Richard Feinberg who performed the retinoscopic examinations.

TABLE I

MEASURES OF CENTRAL TENDENCY AND DISPERSION ON SIX ACUITY TESTS

Test	Mean	S. D.	S. E. of M.	Range
F-3	11.22	1.29	.17	8-15
F-4	10.04	1.45	.19	6-13
F-5	10.69	1.19	.16	8-12
N-1	11.08	1.03	.14	8-12
N-2	10.09	1.40	.19	8-14
N-3	11.35	.98	.13	9-13

TABLE II

PERCENTAGE AND SIGMA VALUES OF EACH TARGET

First Target "Failed"	Test F-3		Test F-4		Test F-5	
	%	Sigma	%	Sigma	%	Sigma
15	1.8	2.10	0.0	(3.00)		
14	0.0	2.10	1.8	2.10		
13	3.6	1.61	7.0	1.35	0.0	(3.00)
12	21.0	.63	22.8	.48	15.8	1.00
11	33.3	—.15	12.3	.16	26.4	.20
10	19.3	—.81	29.8	—.63	28.0	—.53
9	19.2	—2.10	23.0	—1.84	21.0	—1.35
8	1.8	(—3.00)	1.5	—2.10	8.8	(—3.00)
7			1.8	(—3.00)		
6						

First Target "Failed"	Test N-1		Test N-2		Test N-3	
	%	Sigma	%	Sigma	%	Sigma
15			0.0	(3.00)		
14			1.8	2.10	0.0	(3.00)
13	0.0	(3.00)	1.7	1.60	5.6	1.59
12	24 6	.69	22.8	.63	17.3	.77
11	22.8	.07	26.3	—.07	40.3	—.24
10	40.3	—1.16	17.6	—.53	28.0	—1.35
9	10.5	—2.10	21.0	—1.35	8.8	(—3.00)
8	1.8	(—3.00)	8.8	(—3.00)		

In the standard scoring procedure set forth in the manual the score made by a subject on any given acuity test is the score of the most difficult target identified in sequence. Actually the score recorded is the score of the most difficult target "passed." Interpretation of the data is somewhat facilitated by indicating the score of the first target "failed." This has been done in Table II. The frequency of subjects failing targets on the F-3 (far binocular acuity), N-1 (near binocular acuity) and the four monocular tests listed above are given in this table.

The obtained range on the F-3 (far acuity both eyes) test covered eight score values (8-15), on the F-4 (far acuity right eye) test eight score values (6-13) and on the F-5 (far acuity left eye) test five score values (8-12).

The obtained range on the N-1 (near acuity both eyes) test covered five score values (8-12), and on the N-2 (near acuity right eye) test seven score values (8-14), and on the N-3 (near acuity left eye) test five score values (9-13).

In all tests but one, F-4 (far acuity right eye), the distribution of scores appeared to be approximately normal. It will be noted that the distribution of scores on the F-4 test appears to be bimodal. All the

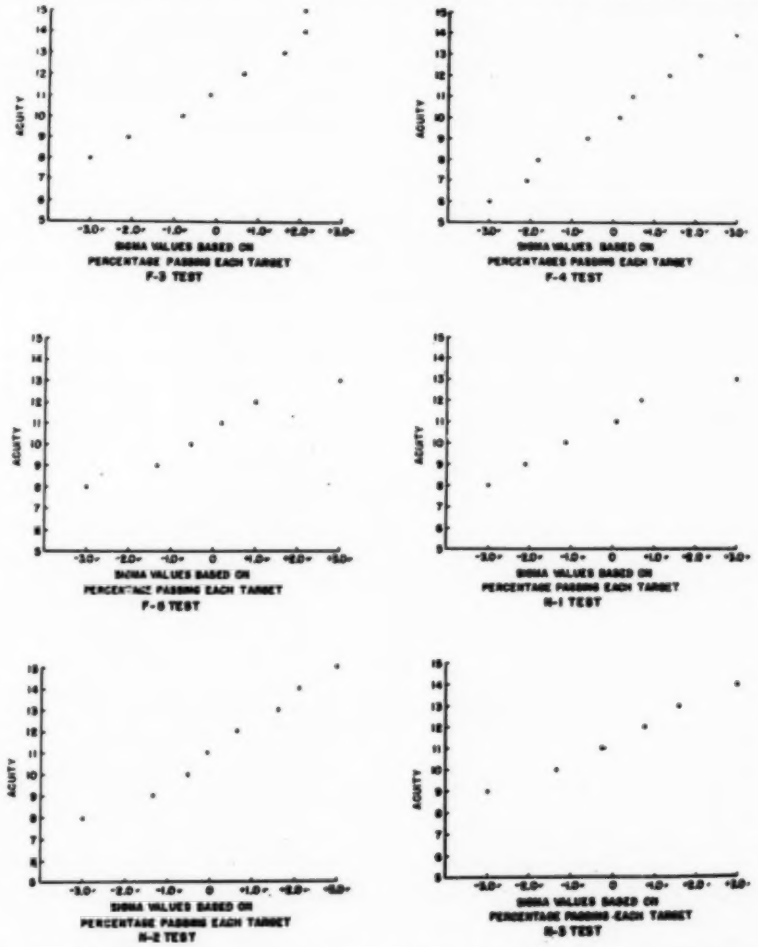

Fig. 1. Relation between sigma value and score value for each of the six acuity tests.

other tests in the present study yield unimodal distributions and other results indicated that bimodality is not an expected characteristic. It would appear that an error in the construction of the target plate might account for this phenomenon. Various instruments were used in the original testing so any error in the test must have been contained in the master plate or the reproduction process. It is also possible that, since the number of cases in the present study is relatively small, the bimodality can be accounted for by sampling error.

The percentage of the total group passing each target of each of the six acuity tests was computed (Table II). Following the technique suggested by Garrett* it is possible to enter a normal probability table with these percentages and determine their corresponding sigma values. Table II shows these values.

The acuity targets in the ortho-rater were devised so that the test scores of a large random sample of an unselected population would form a normal distribution. Points approximating a straight line were obtained when the sigma values of each target were plotted against the target numbers. By plotting the obtained sigma values in the present group, without major refractive errors, against the score values of the acuity targets it was possible to infer the nature of the variation in acuity of this selected group of subjects as compared to the original standardization group from the shape of the resulting curves. Since six curves approximate a straight line it would appear that the variation in acuity among the present selected subjects closely approximates that of an unselected population. These curves are shown in Figure I. The Pearson Product Moment "r" was computed between the sign value and the corresponding ortho-rater score for each of the acuity tests in an effort to get some indication of the goodness of fit of a straight line. The results are shown in Table III.

TABLE III

PEARSONIAN COEFFICIENTS OF CORRELATION BETWEEN SIGMA VALUE AND SCORE VALUE FOR EACH OF THE SIX ACUITY TESTS

Tests	"r"
F-3	.982
F-4	.996
F-5	.984
N-1	.983
N-2	.989
N-3	.995

*Garrett, Henry E., *Statistics in Psychology and Education*, New York: Langmans, Green and Co., 1926, p. 97.

It can be seen from this table that all the values of "r" closely approximate +1.00. It is felt that such high values of "r" indicate a strong probability that the relationship is rectilinear since high "r's" are not possible where the line of best fit is a curve.

CONCLUSIONS

Acuity tests on 57 subjects without major refractive errors reveal that there is considerable variation in visual acuity as measured by the ortho-rater, even among this rigidly selected group.

The nature of the variation in this selected group of subjects appears to be similar to that found in an unselected population.

ABSTRACTS

THE HANDLING OF THE AMBLYOPIC PATIENT. Maynard C. Wheeler. American Journal of Ophthalmology. 32.9.1261-1267. 1949.

This paper describes briefly several pertinent points in the examination and treatment of children with amblyopia.

From the history, it is important to determine as accurately as possible the date of onset, since there is general agreement that the earlier the amblyopia has been present, the longer it will take to improve vision. Previous treatment and results realized are also helpful guides.

The author has found that for young children (aged 4 years) the separate E's, mounted on white plastic squares, are very satisfactory in estimating the visual acuity. In younger children, where the vision cannot be tested reliably, other evidence can be used to indicate an amblyopic eye: if a child uses one eye habitually, the deviating eye will be amblyopic; the expression of the squinting eye and the child's behavior when the fixing eye is covered is characteristic; also, if there is alternation of fixation, one can be fairly sure that both eyes will have good vision.

The most interesting refractive feature in amblyopic cases is the incidence of anisometropia, the amblyopic eye always having the greater ametropia. In fact, if the reverse is found, one should be suspicious that the amblyopia is not from disuse. The author is convinced that it is wrong to adopt occlusion in extreme anisometropia, and while he feels that aniseikonia may be important as an obstacle to binocular single vision, the means of measuring it in squint cases is inadequate.

Careful fundus examination before occlusion is important, even if it is necessary to use a general anesthesia in uncooperative children. The diagnosis of the type of amblyopia is largely of academic interest in young children in whom scotomas cannot be plotted satisfactorily. In cases without gross pathological conditions, the only practical way to distinguish between "pathologic amplyopia" and amblyopia from disuse is by a trial period of complete occlusion. If a case fails to show improvement, or alternate fixation, after two months of complete occlusion, the author is inclined to call it "pathologic" and abandon further occlusion.

The earlier occlusion is begun, the more quickly will the result be obtained. Young children often accept an occluder more readily than older ones. It is important to secure the mother's cooperation by adequate explanation and instructions. The preferred type of occluder is an adhesive bandage worn continuously. Once equal vision is achieved, intermittent occlusion—one month out of three—has been found to be the most satisfactory method of maintaining the vision until the child is old enough for orthoptics and/or surgery—usually about age 6.

Wheeler reported that in a group of 40 patients for whom occlusion had been prescribed, 2 out of 3 cases had an improvement of vision to within one line of the other eye.

R. E. B.

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THE A. O. A. CONVENTION AT MINNEAPOLIS AND A "SUPER" VACATION

The American Optometric Association will meet in Minneapolis next June. This means an opportunity for A. O. A. members to combine a wonderful vacation in America's North Woods country with a stimulating four-day meeting. The Congress dates are June 25, 26, 27 and 28—just the peak of fine vacation weather in Minnesota and surrounding states. Warm days, cool nights—ideal weather for travelling in one of the most beautiful wooded and lake areas in the country.

The Congress in Minneapolis offers a chance to take the trip you've always wanted through Northern Minnesota, Northern Wisconsin and Canada. Take in the convention first, renew acquaintances with fellow optometrists, meet new friends; hear several outstanding speakers; watch the House of Delegates at work. In the evenings, dine and dance in the

famous Flame Room of the Radisson Hotel, or the Minnesota Terrace at the Hotel Nicollet. Or hear the always popular Dick Long orchestra at the Curtis Hotel.

After the convention, pack up your baggage and head for the famous North woods country just 120 miles north of Minneapolis. Drive if you can, but if it's inconvenient to drive, you'll find excellent transportation available. In the North Woods area, with its countless lakes and majestic pine forests for miles around, you can choose from hundreds of resorts where you can relax and suntan, go fishing, golfing, horseback riding or swimming. Nowhere in America are water sports more in vogue. No finer vacationland exists.

Almost 250 miles straight north of Minneapolis is Itasca Park, the headwaters of the Mississippi. Take your camera along and snap a picture of the youngsters wading across the mighty Mississippi.

Another 150 miles farther north is the Lake of the Woods, one of the most beautiful of our Canada-United States border lakes. Or off to the northeast is the wild Arrowhead country with its vast open pit iron mines and the Superior National Forest.

A drive from Port Arthur and Fort William down the North Shore to Duluth, will leave you breathless—two hundred miles of superb scenery along the rocky, wooded shore of Lake Superior. You'll be a better optometrist after a vacation of this kind, and your family will never forget it. It's a chance of a lifetime, and while you're here at the Congress, we of the local group will show you the Twin Cities —a vacationland in themselves with their sparkling lakes and beautiful parks. We are proud of these towns, Minneapolis, world flour mill center, and St. Paul, historic capital of Minnesota.

Plan now to enjoy Northern hospitality at its best. Visit Minneapolis, the A. O. A. Congress city, in June. Write now for reservations and vacation literature. The A. O. A. Congress headquarters will serve you: 610 West Broadway, Minneapolis 11, Minnesota.

CAREL C. KOCH

VISUAL DIGEST—AN EFFECTIVE OPINION MOULDER

The Department of Public Information of the American Optometric Association is working hard to put the magazine, VISUAL DIGEST, across. Dr. Elmer M. Soles, department director, and Dr. Ernest H. Kiekenapp, A. O. A. secretary, are now carrying on the work so ably started by Dr. Walter Kimball.

Optometrists are asked to subscribe to this quarterly publication

and keep the copies on hand in their reception rooms. This is a good idea and one which should be widely followed. Optometrists are also requested to send gift subscriptions to selected local opinion moulders to familiarize them with optometric activities. This, too, is a worthwhile suggestion, but to be effective requires close local optometric cooperation.

Obviously, leading civic leaders and public officials should not be receiving copies of the VISUAL DIGEST from more than one A. O. A. member. Yet this is almost sure to happen if each optometrist makes out a local mailing gift list himself. To avoid this, a list of important local leaders could be prepared by the local optometric society, a VISUAL DIGEST sent to each name on the list with the compliments of the society. This plan would eliminate duplication and assure more complete coverage of opinion moulders in all walks of life.

Where no local society exists, two or more men could meet and prepare a list, dividing the cost of the subscriptions between them. Then their names could be signed to letters to the recipients of the publication. Such coordinated effort should impress civic leaders very favorably. In addition it would result in a larger circulation of the magazine among the persons who should receive it.

State Optometric Associations could follow a similar plan. Here they should limit their mailings to national and state officials such as senators, congressmen, the governor and Statehouse department heads.

Such unified support on the part of local and state groups would make the work of Dr. Soles and Dr. Kiekenapp much easier and more effective. Optometry should give VISUAL DIGEST a real opportunity to prove its worth.

CAREL C. KOCH

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

ACADEMY COMMITTEE APPOINTMENTS FOR 1950

Dr. D. G. Hummel, president, American Academy of Optometry, has appointed the following committees for 1950:

ADVISORY COUNCIL

Dr. Harold Fisher, chairman, Mt. Kisco, New York; Dr. J. Fred Andreae, Baltimore, Maryland; Dr. Walter I. Brown, New Bedford, Massachusetts; Dr. Richard M. Hall, Cleveland, Ohio; Dr. Don R. Paine, Topeka, Kansas; Dr. M. Steinfeld, Paducah,

Kentucky; Dr. R. N. Walker, Winston-Salem, North Carolina; Dr. Arthur P. Wheelock, Des Moines, Iowa, and Dr. Eugene Wiseman, Buffalo, New York.

COMMITTEE ON ADMITTANCE

Members of this committee are responsible for screening applicants for membership in the Academy, reviewing case reports submitted by applicants, and arranging for examinations to be held at the chapter or regional level in their respective regions. The following have been appointed to the committee:

Dr. Arthur P. Wheelock, Des Moines, Iowa, general chairman.

Region 1. New England and Middle Atlantic states. Dr. Oscar L. McCulloch, Holyoke, Massachusetts, chairman; Dr. William G. Walton, Jr., Merion, Pennsylvania; Dr. Bernard A. Baer, Washington, D. C.

Region 2. South Atlantic and Southern states. Dr. Robert N. Walker, Winston-Salem, North Carolina, chairman; Dr. Donald A. Springer, Anniston, Alabama; Dr. Bernard Mazow, Houston, Texas; Dr. Arthur Kitchen, Clearwater, Florida.

Region 3. North Central and Central states. Dr. E. E. Reese, Westerville, Ohio, chairman; Dr. I. M. Borish, Kokomo, Indiana; Dr. Ralph E. Wick, Rapid City, South Dakota.

Region 4. Pacific, Rocky Mountain and Southwest states. Dr. Otto J. Bebber, Denver, Colorado, chairman; Dr. J. Wolff, Spokane, Washington; Dr. Monroe J. Hirsch, Los Angeles, California.

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Dr. Robert E. Bannon, New York, New York, chairman; Dr. Eugene Freeman, Chicago, Illinois; Dr. J. C. Copeland, Chicago, Illinois; Dr. Henry Hofstetter, Los Angeles, California; Dr. F. W. Sinn, Philadelphia, Pennsylvania.

EDITORIAL COUNCIL

The following Fellows were appointed by President Hummel to serve on the editorial council of the Academy:

Dr. J. Fred Andreae, Baltimore, Maryland, chairman; Dr. Carel C. Koch, Minneapolis; Dr. Robert E. Bannon, New York, New York; Dr. I. M. Borish, Kokomo, Indiana; Dr. V. J. Ellerbrock, Columbus, Ohio; Dr. Richard Feinberg, Forest Grove, Oregon; Dr. Harold M. Fisher, Mt. Kisco, New York; Dr. Eugene Freeman, Chicago, Illinois; Dr. Glenn A. Fry, Columbus, Ohio; Dr. Ralph H. Green, Boston, Massachusetts; Dr. James H. Grout, Chicago, Illinois; Dr. H. W. Hofstetter, Los Angeles, California; Dr. D. G. Hummel, Cleveland, Ohio; Dr. Donald Kratz, Souderton, Pennsylvania; Dr. Meredith W. Morgan, Jr., Berkeley, California; Dr. John C. Neill, Philadelphia, Pennsylvania; Dr. Harold Simmerman, Woodbury, New Jersey.

COMMITTEE ON NOMENCLATURE AND STANDARDS

This committee is responsible for making recommendations to the profession for keeping the nomenclature and refractive standards of optometry uniform:

Dr. Glenn A. Fry, Columbus, Ohio, chairman; Dr. Julius Neumueller, Haddonfield, New Jersey; Dr. Robert Graham, Pasadena, California.

COMMITTEE ON STUDENT COUNSEL

This committee is charged with presenting the ideals of practice and the research program of the American Academy of Optometry to the students in our optometric schools.

Chairman, Dr. R. W. Tubesing, Richmond, Indiana; Dr. V. J. Ellerbrock, Columbus, Ohio; Dr. H. W. Hofstetter, Los Angeles, California; Dr. Richard Feinberg, Forest Grove, Oregon; Dr. James Grout, Chicago, Illinois; Dr. George W.

Keevil, Toronto, Ontario, Canada; Dr. Harold M. Fisher, Mt. Kisco, New York; Dr. Eugene Freeman, Chicago, Illinois; Dr. George J. Haus, Memphis, Tennessee; Dr. O. L. McCulloch, Holyoke, Massachusetts; Dr. Meredith W. Morgan, Jr., Berkeley, California; Dr. Julius Neumueller, Haddonfield, New Jersey.

COMMITTEE ON CHAPTERS AND NEW CHARTERS

Appointed to serve as a liaison group between the parent body and the chapters are the following Fellows:

Dr. Lawrence Fitch, Newtown, Pennsylvania, chairman; Dr. A. G. Billmeier, Denton, Maryland; Dr. B. H. Bohall, Oswego, New York; Dr. Robert L. Dewey, Philipsburg, Pennsylvania; Dr. Arthur B. Emmes, Berkeley, California; Dr. John J. High, Rocky Mount, North Carolina; Dr. O. H. Johnson, Jonesboro, Arkansas; Dr. Arthur S. Kitchen, Clearwater, Florida; Dr. H. B. Hewett, Lake Charles, Louisiana; Dr. J. C. Russel, Brunswick, Maine; Dr. I. Irving Vics, Albany, New York; Dr. John J. Wey, Painsville, Ohio; Dr. Ernest C. Wille, Jr., Denver, Colorado; Dr. E. C. Wilson, Rutland, Vermont; Dr. J. Wolff, Spokane, Washington.

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Dr. Glenn A. Fry, Columbus, Ohio, chairman; Dr. Mathew Alpern, Columbus, Ohio; Dr. Richard M. Hall, Cleveland, Ohio.

LOCAL CHAPTER ACTIVITIES

NORTHEASTERN OHIO CHAPTER

The Northeastern Ohio chapter is sponsoring its third annual conference on reading problems this month in Cleveland. On February 25, hundreds of optometrists and educators will hear papers by specialists in the reading field and participate in roundtable discussions of reading problems.

This year, Dr. William S. Gray, Professor of Education, University of Chicago, will start off the conference with a paper, "Foundation Stones in the Road to Better Reading." Also on the morning program is Dr. Leland Jacobs, Associate Professor of Education, the Ohio State University, who will speak on "Literature's Contribution to the Improvement of Reading."

The afternoon session will again feature Dr. Gray with a slide-illustrated lecture on "Growth Periods in Reading from the Beginning through the Twelfth Year." Dr. C. B. Allen, Professor of Education, Graduate School, Western Reserve University, will preside over discussion sessions.

Conference chairman for 1950 is Dr. John R. Hubbard of Cleveland. Seven leading Ohio educators are serving on the advisory committee.

SOUTHERN CALIFORNIA CHAPTER

The January meeting of the Southern California chapter was devoted to a review of papers and proceedings of the Cleveland annual convention of the Academy. Drs. Ernest Hutchinson, Monroe Hirsch and Henry Hofstetter, convention delegates, each gave a brief report.

CURRENT COMMENTS

Virginia Huck
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

STENSTROM MONOGRAPH NOW AVAILABLE

In 1946, Dr. Solve Stenstrom, ophthalmologist from Goteborg, Sweden, published the results of a most significant research study. This piece of experimental work in which hundreds of subjects were used, determined the most significant factors causing refractive errors. After compiling extensive data, Dr. Stenstrom was able to prove that the variations of the anterior-posterior axis of the eye were the major determining factors in establishing an eye as either myopic, or hyperopic. Other elements entered in, to be sure, but the front-to-back length of the eye was responsible for about 70 per cent of all refractive variations, Dr. Stenstrom discovered.

Dr. Stenstrom's findings were originally published in German. Later, Dr. Daniel Woolf, faculty member of the School of Optometry, Columbia University, translated the material into English, and as an Academy project this well written translation was published with the original Stenstrom illustrations and tables in six chapters in the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY in 1948.

The original Woolf translation has been submitted to Dr. Stenstrom, who graciously made a number of suggestions and revisions, further clarifying the text. The approved English translation has now been reprinted in regular Academy monograph form as *"Investigation of the Variation and the Correlation of the Optical Elements of Human Eyes,"* by Solve Stenstrom, translated by Daniel Woolf, Monograph, Number 58. This illustrated monograph, 72 pages plus covers, will be sent to professionally interested persons postpaid for $1.00. Send your remittance to the American Academy of Optometry, 1502 Foshay Tower, Minneapolis 2, Minnesota.

HARRISON RESIGNS POST AS EDITOR

The JOURNAL OF THE OPTICAL SOCIETY OF AMERICA has announced the resignation of its editor, Dr. George R. Harrison, who has served the magazine for the past 10 years. In an editorial in the January issue, the Society expressed its appreciation for the editorial work carried on so ably by Dr. Harrison.

Dr. Harrison became editor in 1939 while professor of physics and director of the research laboratory at the Massachusetts Institute of Technology. In 1942, he was appointed Dean of Science at M. I. T. His work in the field of science has been recognized by the award of the Rumford Medal by the American Academy of Arts and Sciences and the Frederic Ives medal for Distinguished Work in Optics, by the Optical Society of America, among other honors.

Dr. Wallace R. Brode, Associate Director, National Bureau of Standards, Washington, D. C., has taken Dr. Harrison's place as editor. Dr. Harrison will serve as an associate editor.

OPTOMETRISTS IN THE NEWS

Dr. E. C. Nurock, Trenton, New Jersey, was elected to the Better Vision Institute Board of Directors at its recent quarterly meeting. Dr. Nurock will fill the unexpired term of Dr. Earl H. Ridgeway, Trenton, who resigned due to pressure of other work.

Dr. Matthew Luckiesh writes that he is now available for lectures and consultation on light, color, lighting, vision and seeing, having formally retired from the directorship of General Electric Company's Lighting Research department last December. Dr. Luckiesh may be reached by writing to him at 21175 Shaker Boulevard, Shaker Heights 22, Ohio.

Dr. John D. Perry, Jr., Winston-Salem, North Carolina, and Dr. Malcolm H. Kelly, Oxford, Pennsylvania, have been elected to the Board of Trustees of Pennsylvania State College of Optometry, according to an announcement from Dr. Albert Fitch, board president.

VOLUME 26 AVAILABLE IN MICROFILM

A reminder to our subscribers that the Journal is available on microfilm for the year 1949 from University Microfilms, 313 North First Street, Ann Arbor, Michigan. Some time ago, the Journal entered into an agreement with this firm to film the magazine for distribution to libraries and subscribers. The cost of a microfilm of the entire Volume 26 for 1949 is $2.20.

NEW ENGLAND CONGRESS

Scientific and educational films on vision will be featured at the coming 28th congress for New England optometrists. The films will be shown continuously during one day of the four-day conference to be held March 12-15 at the Hotel Statler in Boston.

Speakers for the meeting include Dr. Thaddeus R. Murroughs, Chicago College of Optometry; Dr. Carl F. Shepard, Chicago; Dr.

Emanual Krimsky, Brooklyn, New York; Dr. Russel G. Stauffer, Temple University; Dr. Lorrin A. Riggs, Brown University; Dr. Bowling Barnes, American Optical Company, and Mr. Frederick Jobe, Bausch & Lomb Optical Company.

GRADUATE SEMINARS AT LOS ANGELES COLLEGE

On February 27, Los Angeles College of Optometry will hold the first in a series of weekly seminars for graduate students, practicing optometrists and others interested in visual science. Speakers for the seminars will be members of the college staff, guest lecturers and researchers in the field of vision. The new course is under the direction of Drs. H. A. Jankiewicz, M. J. Hirsch and Henry W. Hofstetter.

LEICA LENS DESIGNER PASSES

Scientists the world over are mourning the recent death of Professor Max Berek, creator of Leica lenses. Professor Berek died on October 15 in Frieburg, Germany, at the age of 63. He was associated with the Leitz Works in Germany for 37 years—being director of the Department of Science at the time of his death. He created the full range of lenses for the famous Leica camera and aided in the development of many of the lenses and accessories necessary for taking, enlarging, projecting and reproducing Leica photographs.

Professor Berek also authored *"Fundamentals of Practical Optics,"* now a standard work of optical design. At the time of his death he was working on a four-volume textbook on optics, but unfortunately completed only the first two volumes.

Among the many honors accumulated by Professor Berek during his distinguished career was the *Grand Prix* awarded in 1938 at the World's Fair in Paris. In recognition of his special achievements in the field of optics, he was appointed a professor by the University of Marburg in 1925, a post he lost during the Nazi regime, and regained after the war.

In addition to working out problems in practical optics, the German scientist made outstanding contributions in the fundamentals and problems of theoretical optics. His theoretical work included the establishment of a fundamental physiological principle of the perception of light stimuli, studies of coherence and consonance of light, and analysis of the efficiency of binocular telescopes.

NEWS BRIEFS

A new chapter of Omega Delta, national professional optometric fraternity, was organized in January at the Chicago College of Op-

tometry. Dr. Jerome Conlogue, Peoria, Illinois, national grand president of the fraternity served as master of ceremonies. Dr. E. S. Takahashi, faculty member of Chicago College, will serve as the new chapter's sponsor. The new chapter will be known as Mu Chapter. . . . A new 15-minute recording on children's vision has just been released by the A. O. A. The recording, made by Dr. G. N. Getman, Luverne, Minnesota, and professional actors, is available to state associations for use on local radio stations. . . . LIFE magazine carried an interesting article (January 16 issue) on vision and perception. "Your Eyes Do Deceive You," discusses with illustrations, the difference between vision and perception. Examples in the article were devised by Professor Adelbert Ames, Jr., of Hanover Institute. . . . The Nebraska Optometric Association has set April 12 and 13 as the dates for their annual convention at the Hotel Paxton, Omaha, Nebraska. Dr. G. N. Getman will be the principal speaker. . . . Dr. Henry L. Wolfe of the Wolfe Foundation, Marshalltown, Iowa, and Dr. Franklin M. Foote, Executive Director of the National Society for the Prevention of Blindness were speakers at the February State meeting of the New Jersey Optometric Association. . . . Proceedings of the 42nd annual convention of the Illinois Optometric Association in Chicago were televised by WGN-TV. Dr. Carl Shepard, Chicago, demonstrated proper use of a TV set and how television can be used in visual training. . . . Dr. Charles Sheard, now distinguished lecturer in ophthalmology at Tulane University, gave two papers at the recent annual meeting of the Alabama Optometric Association: "Binocular Vision," and a resume of his 50 years' observation in the fields of ophthalmology, optometry and opticianry. . . . Dr. Joseph I. Pascal, New York City, was the speaker at the centennial meeting of the Reading Eye, Ear, Nose and Throat Society on January 18. The Society also elected Dr. Pascal to honorary membership. . . . The Liberty Optical Company, Newark, New Jersey, has joined B. V. I. as a manufacturer member. . . . E. Hutson Titmus, Jr., general manager, Titmus Optical Company, was named "young man of the year" of Petersburg, Virginia. The honor was awarded by the Petersburg Chamber of Commerce to Mr. Titmus for outstanding community leadership, particularly his leadership in the raising of more than a million dollars for the Petersburg Hospital Authority in 1949.